AB 32 Scoping Plan: Forest Sector

The forest sector includes forest resources in wilderness, rural, urban, and suburban landscapes, in rangelands capable of growing trees, and the production and consumption of forest products. California is comprised of a diverse landscape of over 100 million acres; 33 million acres are characterized as forest and 47 million acres can be classified as rangelands. Across the 33 million acres of California's forests, there is a broad range of tree species, tree sizes and density. Conifer forests and woodlands cover over 21 million acres and are most extensive in the Sierra, Modoc, and Klamath/North Coast bioregions of the State. Hardwood forests and woodlands cover nearly 10 million acres and extend along the perimeter of the Sacramento and San Joaquin Valleys and throughout the coastal ranges. There is also a diversity of forest ownership in California. Forty-five percent of ownership is private, 52% is federal, and 3% is State or Local government. The management of the existing carbon pool is also influenced by land ownership. The most productive timber growing portion of California's forests are the 16.6 million acres of public and private timberland. Timberland is defined as land capable of growing more than 20 cubic feet of wood per acre per year. Well over half of public timberlands have been administratively withdrawn over the past two decades for a variety of purposes and have been directed to primary uses other than timber production.

Forest landowners include the following broad categories:

- *Private Landowners:* Both industrial and non-industrial landowners own forestland in California. Non-industrial landowners include a wide variety of landowner size, including ranchers and small landowners.
- *Public Landowners:* Forests in California under public ownership includes the United States Forest Service (USFS), National Park Service (NPS), Bureau of Land Management (BLM), Bureau of Indian Affairs (BIA), Bureau of Reclamation, State Department of Parks and Recreation, State Lands Commission, Cal Trans, Department of Water Resources, Department of Water Resources, Department of Fish and Game, Wildlife Conservation Board, and the Department of Forestry and Fire Protection (CAL Fire).
- *Non-Profits: California has a rich population of non-profit organizations that are involved with management of rural and urban areas.*
- *Local Government:* City and County government manage urban forests that are an important component of the forest sector.

Forests are an important part of the California economy. The forest products industry provides about one percent of the total value added, personal income, and employment in the state (Laaksonen-Craig, Goldmand and Mckillop, 2003). California is a major timber producing state. For 2005, the total statewide timber harvest was 1.7 billion board feet valued at about $547 million dollars. All but 13% of this volume came from privately owned lands. Timber in California is mostly harvested for sawlogs. California imports nearly 80 percent of its wood (California Forest Products Commission). Much of this supply comes from other Western states. Other sources are Southern states and Canada. To a large

degree, regional, national, and global forces influence price and other factors in the forest sector. Current strategies have not been developed with an eye toward out-of-state competition.

Primary and secondary wood and paper products industries employed about 112,700 workers in 2000 in California, earning $4.5 billion annually (Morgan et al, 2004)[1]. There were 47 sawmills and other wood products facilities with a capacity to process about 2.18 billion board feet of timber. This represents a decline of 60% from 6 billion board feet capacity of the mid-1980s, which is due to declining available timber supplies, improved mill efficiency and international competition and other market factors.

To the extent that there is a higher cost of doing business in California compared to other sources of imports, there are disincentives to invest in management of California's forest sector. If implementation of climate change strategies for the forest sector increases cost of doing business, then the private sector investment in forest management may decrease. On the other hand, if climate change strategies for the forest sector add income or reduce the relative cost of doing business compared to other states, then there may be a positive impact on private investment.

2) Unique considerations or issues with sector

The Forest Sector is the only sector that removes CO2 from the atmosphere and stores it long-term. The sector is based on a biological system which may respond slowly to management measures. It is not until year ten that a newly planted tree is established and adding mass in the form of wood and carbon. The tree stores carbon at the fastest rates from around year 10 to somewhere between 40 and 80 years of age, at which point it continues to store carbon but at a slower rate. Somewhere between 80 and 150 year of age a stand of trees reaches a balance where the amount of carbon added is lost to tree mortality and subsequent decay.

The Forest Sector provides other resource and social returns while it is growing and storing carbon. A healthy forest stand provides recreational opportunities, clean water, wildlife habitat, fisheries, bio-energy and erosion protection. These ecosystem services are beginning to be evaluated economically. One bio-energy study estimates the combined value of these benefits to be in the area of $0.11 per Kwh of energy produced from woody biomass. There is also some ongoing work to include the value of co-benefits in the cost of carbon sequestration projects. Murdock et al. (2007)[2] provides a methodology for screening afforestation projects to identify projects with greater environmental co-benefits and to prioritize these.

The Forest Sector carbon benefits occur over large areas of the landscape and significant periods of time. Unlike engineered projects or measures that

[1] California's Forest Products Industry: A Descriptive Analysis. T. A. Morgan, C. E. Keegan III, T. Dillon, A. Chase, J. Fried, and M. Weber. USDA-USFS PNW-GTR-615. July 2004. http://www.bber.umt.edu/forest/pdf/fidacs/ca2000.pdf

[2] Murdock, Zganjar and Stanley. October 2007. Terrestrial Carbon Sequestration in the Northeast. Part 5: Environmental Co-benefits of Carbon Sequestration. Opportunities. www.sampsongroup.com/Papers/NE%20Carbon%20Sequestration%20Part%205.pdf

reduce emissions at a point source (e.g. stack or tailpipe), the forest sector sequestration benefits are accrued through tree growth over large areas of the landscape, including urban areas. With such a large land base carbon benefits need to be accounted for in average stocks (amount of carbon stored). Some acres of forests will have increasing stocks of carbon stored while other will have a static or decrease in carbon stocks during the same time period. This condition of constant change requires the Forest Sector to use a carbon stock change accounting methodology and results in using a statistical analysis to determine carbon stored over spatial and temporal parameters.

The Forest Sector is a source of mitigation for climate change, but is also subject to climate impacts that may restrict its mitigation capacity. Warming temperatures, declining snow packs and earlier spring runoff are already impacting forest health and increasing the risk of wildfires. Continued land use changes combined with past management practices, shifting weather patterns, and increasing pest infestations will increase the damage from wildfires. Species ranges and distributions may change and forest type conversions are likely to occur. The resilience to existing and new stressors will depend on maintaining forest health through adequate biological and species diversity, tree vigor and functioning ecosystems. Adaptation strategies need to be included in implementation plans to minimize climate impacts.

Forest Sector Overview

3) Proposed emission reduction pathways for the sector

Strategies for emissions reductions include regulatory and statutory changes, market incentives, tax- or regulatory-relief, forest accounting protocols, and subsidies or carbon taxes/fee revenues. Opportunities to increase forest sector climate benefits are more likely to come from institutional changes than management or production improvements.

The Board of Forestry and Fire Protection has the regulatory authority and responsibility for timber harvesting in the State. It has been asked by ARB to consider GHG impacts during future regulatory development and adoption.

The creation and maintenance of carbon markets for forest carbon, both voluntary and compliance-based, will increase sequestration by providing landowner incentives to increase carbon stocks on their ownership. The value of carbon at $10/t is sufficient to interest landowners in changing their management practices to increase carbon storage. Updating the current California Climate Action Registry (CCAR) Forest Protocols can create the opportunity for a larger number of forest landowners to participate in carbon offset markets. The success of these markets will depend upon quality of the carbon that is being sold, which will depend upon the accounting principles applied in development of forest protocols used to verify and register carbon sequestration projects.

Other incentives include providing landowners reduced tax or regulatory liabilities, which will encourage the retention of working forest landscapes, instead of land division and development. Additional opportunities may exist for subsidies or carbon taxes/fee revenues collected and reinvested in carbon sequestration projects. An example is an approach proposed by the California Energy Commission in the current Integrated Energy and Policy Report (IEPR).

The Commission proposes a feed-in tariff to support increasing the amount of renewable energy purchased by the power companies. Power companies would pay a premium price for power produced using renewable energy (biomass, solar, wind, geothermal). If accepted this would add significantly to the states Renewable Portfolio Standard objectives.

4) The potential for leakage from the sector

Out-of-state market leakage is a very likely outcome from the proposed forest management strategy. Full life-cycle analysis is needed to identify the potential for additional leakage. Enhanced carbon sequestration (more trees kept on the land longer) on timberlands will decrease supply of timber from California forests and increase the harvest of it elsewhere, thus shifting harvesting emissions outside the state. Lumber production in California has declined over the past 20 years while lumber demand has increased, resulting in increasing imports from outside California (Laaksonen-Craig et al, 2003).[3]

Measures to reduce consumption of forest products within the state, thus lowering demand from elsewhere, have been proposed. These would require a comprehensive accounting framework for the forest sector to track emissions associated with wood product consumption, from growth through use to disposal. State-specific estimates of harvested wood product flows would then be developed including, in particular, cross-border imports and exports. Some information is already collected on forest product consumption, but could be substantially expanded.

Thirty percent of California-grown timber is exported out of California. Consideration could be given to promoting California-grown products and actions in-state that contribute to climate solutions and provide in-state purchasing preferences and priority in regulatory queues whenever feasible, and give preference to offset products certified by the CCAR in voluntary or cap-and-trade market systems.[4]

5) Role of local, state, and federal government

Measures under the forest sector will require active participation by local, state, and federal government to implement fully and to realize maximum GHG benefits. Jurisdiction and authority issues are presented by strategy.

<u>Reforestation</u>

This strategy is implemented through a number of separate measures that cumulatively increase the acres of land that are reforested annually. The California Forest Improvement Program (CFIP) administered through CAL FIRE has existing authority to conduct reforestation projects with private land owners. Through additional funding the existing cost share program will be able to increase the amount of reforestation that is done on private lands. On state lands authority exists to implement reforestation projects. On USFS and other

[4] Laaksonen-Craig, Goldman, McKillop. 2003. Forestry, Forest industry, and Forest Products Consumption in California. Division of Agriculture and Natural Resources Publication 8070, University of California, Davis. http://anrcatalog.ucdavis.edu.

[4] See recommendations from ETAAC FINAL REPORT, February 11, 2008, p. 7-13.

public lands federal agencies have the authority to implement reforestation projects.

Forest Conservation

The State has the existing authority to make land purchases and conservation easements as proposed under this set of measures. The Wildlife Conservation Board is the primary state authority for conservation easements or land acquisitions on forest and range lands. Local government and some non-profit groups can enable conservation easements. Where changes in timberland occur due to land use changes and deforestation, CAL FIRE has the responsibility and authority for timberland conversions (PRC 4621 et seq) and may require mitigation for these projects. Local Government has the primary land use authority under the California Environmental Quality Act (CEQA) and Government Code. Collaboration will be required with these entities to reduce the loss of forestland to land use changes which will result in vegetative cover conversions.

Forest Management

The State has existing authority to implement regulatory actions related to forest management of private forest lands. Regulatory actions that result in additional carbon sequestration are enforced through Forest Practice Rules. Some forest management actions are voluntary; the carbon benefits of these could be measured using CCAR forest protocols. Forest management actions on federal lands are subject to NEPA. There are also other agencies with jurisdiction over forestlands that affect implementation of forest management projects. These include the Regional Water Quality Control Boards, Department of Fish and Game, Air Quality Management Districts, and parallel federal agencies. Implementation will require continued collaboration of these agencies to minimize any barriers to strategy implementation.

Urban Forestry

Measures to increase tree planting by the State consists primarily of voluntary actions by local agencies or non-profits. They can require authority from local government to implement actions that maximize GHG benefits. Public utilities may also work directly with individual homeowners.

Wildfire/Fuels

The authority to implement measures related to wildfires and fuel hazard reduction depends on the land base. Under the Public Resources Code (PRC 4125-4128) the State assumes primary responsibility for protection of natural resources from damages of fire on forest and range lands that are designated as State Responsibility Area (SRA) lands. Consistent with Public Resources Code 4131, the Board of Forestry has adopted the finding that the most effective long-term method of reducing conflagration threat, damage to natural resources, and life and property is a program of fire environment modification. Fire environment modification includes programs of fuel reduction, installation of fire defense improvements, and fire safety control of life and property exposures.

The two most prominent enforcement codes for fuel reduction and prevention are PRC 4291 and 4293. PRC 4291 mandates removal of all brush, flammable vegetation, or combustible growth that is located within 100 feet from the building or structure or to the property line. PRC 4293 requires clearance of 4 feet around any transmission line operating at 2,400 or more volts, 6 ft around any line operating at 72,000 or more volts, and 10 ft clearance around any line operating at 110,000 or more volts.

Through the Vegetation Management Program CAL FIRE has the authority to cooperatively treat vegetation and fuels on private and public lands. A variety of methods, including both prescribed fire and mechanical means are allowed.

On USFS lands the federal government has authority to implement reforestation projects and other vegetation management related projects. The authority is discussed in the Healthy Forests Restoration Act (HFRA) of 2003 (P.L. 108-148). The HFRA contains a variety of provisions to expedite hazardous-fuel reduction and forest-restoration projects on specific types of Federal land that are at risk of wildland fire or insect and disease epidemics .

PRC 4129-4135 provides that a county may assume the responsibility for protection of SRA within the county. Counties assuming this responsibility pursuant to The Board policy found in Title 14, California Code of Regulations (14CCR), are known as “Contract Counties”. Numerous counties have fuel reduction ordinances. For example, after the 2003 fire season, San Diego County strengthened its brush management program to reduce fire risk.

Existing Actions on Federal Lands

Of the 33 million acres of forest land in California roughly 60% of the land base is in some form of public land management. The National forests represent the largest land holdings (47%), but other federal (BLM 5%, NPS 4%), state (2%) and local government (1%) have significant forest land.

Ownership along with the condition of forest stands will greatly influence the quantity and type of environmental services. In general, federal forests tend to have older stands with larger size classes (Christensen, 2007) that represent a substantial carbon pool for the state. Land management policies and practices on these lands can greatly affect future forest carbon sequestration. Policies are laid out in long-term land management plans whereas actual land practices and programs of work are a product of site-specific environmental analyses and decision documents conducted in accordance with the National Environmental Policy Act of 1969. Public lands programs of work are largely the product of public engagement, review and consensus, as well as sufficient congressional appropriations to complete the proposed actions. There is a range of activities on federal forests that are consistent with goals to offset GHG emissions.

Reforestation is commonly performed in areas that have experienced high intensity fires or severe insect mortality and also takes place following timber harvesting. In the last three calendar years, 9,000 acres per year was completed on Forest Service lands. A recent unpublished USFS assessment concluded that an additional 14,000 acres per year could be accomplished for up to a decade if funds were available.

Federal agencies have been actively involved in implementing fuel treatment projects. The biggest threat to preserving federal forests, to maintain a large

carbon sink, are increasing risks of high severity wildfires and forest health issues (disease, pests, exotics). Most of these agencies are involved in fuel reduction projects to reduce the risks of high severity wildfires. For example, in 2007, the USFS implemented over 100,000 acres of fuel treatments on public forests. The NPS (11,188 ac in 2007) and BLM (21,922 ac in 2007) are also actively implementing fuel reduction projects on public lands. The USFS in California estimates that an additional 65,000 acres per year of fuel hazard treatments could be treated and an additional 40,000acres of forest health treatments could be performed with sufficient resources to support such activities.

Woody biomass is a by-product of thinning and other fuel reduction treatments. The process of thinning stands to reduce the risk of wildfire creates significant volumes of woody biomass available for energy production. This by-product can be utilized as a raw material for some forest products and as a renewable source of energy. Woody biomass constitutes approximately 1/3 of the volume of fiber removed from Federal forest lands in California each year. Federal agencies are involved in a broad range of forest health issues that includes issues, such as, Sudden Oak Death and Bark Beetle infestations that affect large tracts of forest land across California.

6) Public-private interface

Jurisdictions and governance structures for private and public forestlands differ. Governance is the framework of laws and institutions through which decisions are made about use, management, budget and program funding, investment, and conflict resolution on California's forests and rangelands. The framework includes the legislative, executive and judicial branches of government. These occur at various governmental levels—federal, state, regional, and local. Private firms and market institutions, voluntary associations such as watershed groups, and international forums are also involved.

At the federal level, at least 70 laws and Executive Orders relate to California's forests and rangelands. The most significant laws for California have been the federal Endangered Species Act, Clean Air Act, and Clean Water Act. Six federal agencies play a key role in the way public lands containing forest and rangeland resources are managed in California. These include the USFS, BLM, NPS, U. S. Fish and Wildlife Service (FWS), U. S. Environmental Protection Agency (USEPA), and National Marine Fisheries Service (NMFS).

At the state level, over 30 laws and Executive Orders deal with aspects of forests and rangelands. A number of departments, boards, and commissions within the Resources Agency and the California Environmental Protection Agency have regulatory influence on private forest and rangeland management. Several state agencies own and manage forest and rangeland properties for a variety of goals. The California Wildlife Conservation Board and various conservancies enable easements and contractual commitments from landowners to ensure management of specific environmental protection and/ or enhancements.

In California, local government also can affect the use of forest lands. Influence occurs in a variety of ways, particularly through zoning and nuisance ordinances, the General Plan process, land use policies, and project review

under the California Environmental Quality Act (CEQA). In addition, some counties, especially those in the San Francisco and Monterey Bay regions, fund extensive acquisition and easement programs for forests and rangelands.

One product of the overlapping structure of governance in the forestry sector is that a variety of mechanisms now exists that will help public and private collaboration. This is true at the regulatory, program, and project review levels. Boards like the Air Resources Board, the Board of Forestry and Fire Protection, the State and Regional Water Quality Control Boards, and the Fish and Game Commission have established stakeholder processes and provide opportunity for public input in policy development, rule making, grants and assistance, public land use planning and management, and CEQA reviews associated with project permitting. Federal agencies with control over forestlands operate in their own established public participation and comment processes. Some even collaborate with private or non-profit entities on management, stewardship, restoration and monitoring activities for those lands.

Public and private collaboration has not come easily in the forest sector, however. Although there are notable examples of collaboration on public and private lands through grant and assistance programs, restoration and stewardship projects, and watershed level organizations and capacity building, the legal system has been the most significant factor in resolving conflict on both public and private lands. The reasons behind many of these lawsuits relate to objections by neighbors, the public, and interest groups concerning the location and extent of harvesting or the impacts on water supplies, amenities, and threatened or endangered species. The result of lawsuits and agency response has been a much more involved public in providing input and oversight for decisions made by governmental agencies.

California voters have increasingly been asked to resolve very complex issues and to commit to substantial investment in the forestry sector. Ballot propositions have been advanced relating to several issues: forest practices, range and wildlife management, and investment in water, air, parks, habitat, and related infrastructure. Initiatives approved through the ballot box have focused on protecting wildlife from certain control methods, acquiring habitat, and funding millions of dollars for stream restoration, upper watershed work, and other projects related to improved water supply.

There has been increasing federal and state funding at the watershed level, as well as development of robust watershed and community groups at the local level. The role of non-profit organizations has greatly expanded, especially in facilitating negotiation of agricultural and conservation easements, wherein a landowner gives up rights to subdivide and sell land for development in exchange for tax benefits and/or payment.

7) Interaction with other sectors

Measures that are implemented by the forest sector have many co-benefits that may interact with other sectors.

<u>Land Use</u>

Tree planting under the urban forestry strategy has direct overlap with the goals of the “Cool Communities” strategy in the Land Use sector to encourage the

development of communities that have lower surface temperatures. Urban tree planting may also have overlap with the Land Use sector strategies for "Landscape Guidelines" and "Smart Growth". In addition, the forest sector Reforestation mitigation measure would require developers to provide 1 to 2 acres of reforestation as mitigation for every acre lost to development when converting forest land to other uses.

Waste

The measures within the forest sector promote increased wood-use efficiency. The by-products of manufacturing timber and disposal of wood products in landfills create a potential overlap with the Waste sector. The fate of wood products discarded in landfills creates a large pool of carbon. Studies have shown that while a portion of this carbon pool decays and contributes to GHG emissions, a large amount remains in the landfill as long-term storage as a carbon sink (Micales and Skog, 1999)[5]. The planting of additional trees as part of an Urban Forest strategy will generate additional green waste. The processing of additional green waste (composting, biofuels, or landfills) will likely overlap with issues that are being addressed under strategies in the Waste Management sector.

Agriculture

The development of biomass plants that use forest sector wood waste has potential overlap with the agriculture sector which may provide biomass from orchards and green waste from other agricultural activities. The Forest Sector measure to afforest rangelands capable of supporting trees would also require interaction with the agriculture sector as it affects livestock grazing interests.

Water

The Urban Forestry measure would greatly expand the planting of trees in urban areas. Extensive tree planting may require additional water use, but urban trees also reduce stormwater treatment needs, may contribute to water reuse and thus reduce carbon footprint of water use. The amount would vary with the type of tree planted and site conditions. Water requirements for extensive tree planting in urban areas may need to be considered in the Water Sector strategies that address water use.

Energy

The development of biofuels has a direct overlap with the Energy sector. The forest sector has fuels management as part of a strategy to reduce the risk of large catastrophic wildfires. The material removed from vegetation treatments can be used to produce electricity and biofuels. The increased use of biomass as a fuel source displaces the GHG emissions that would otherwise occur from fossil fuels. Energy savings from cooling effects of tree shade in urban forests urban forests would overlap with the Energy sector.

[5] Micales and Skog, 1999. The decomposition of forest products in landfills. International Biodeterioration and Biodegradation 39 2–3.

8) Integration with regional, national, or global programs

Integration of a forest sector carbon emission reduction program with outside programs will be complex, because of differing forest practice rules, differing definitions of baseline, permanence and additionality, leakage issues, and the voluntary nature of many programs. As market opportunities expand throughout the region and the nation, voluntary offset programs in the forest sector may integrate with other offset programs being developed in other states. Maintaining rigorous quality standards, as established by the CCAR process, is essential to integrating outside efforts with ours.

Coordinating with federal forest partners will be key to integrating the California forest sector into the regional and the national program. The majority of forest lands in the state, in the region, and in the nation are managed by the USFS. The USFS is participating in the key emission reduction efforts and planning sessions in California, and developing their own approaches at the national level.

In addition, forest sector programs will need to be consistent with regional efforts (see the Western Climate Initiative[6]) and developing national carbon markets.

9) Consideration of longer-term goal for 2050

The benefits of actions by the forest sector start slowly, but increase dramatically over time. With respect to direct sequestration reductions, the proposed actions under the Forest Sector are expected to remove 4 MMTCO2e in 2020 and 27 MMTCO2e in 2050. Even with the given uncertainty associated with these estimates one would expect carbon sequestration to increase dramatically over time as trees become well established and then the annual increases would level off as trees reach full maturity. It is important to recognize that delaying the implementation of measures and actions that are proposed for 2009-2010 will decrease the likelihood of achieving these benefits in 2050.

Emission Reduction Strategies

10) Description of the sector's emission reduction approach

The Forest Sector analysis focuses on the five (5) measures identified by the Climate Action Team, written up in the CAT Macroeconomic Analysis and available in full on the ARB Forest Scoping Plan website[7]. As a part of the Scoping Plan process to achieve the State's 2020 emission limit, ARB solicited input from stakeholders to help identify, assess and prioritize measures based on specific criteria, including reduction potential, technical feasibility, cost effectiveness, implementation barriers, implementation timeline, and impacts on industry, environment and the EJ communities. Thirty-five new ideas were identified during the ARB stakeholder sessions, and additional analyses were included for reforestation by USFS, carbon market for forest management projects, forest conservation, mitigation, and voluntary urban tree plantings.

[6] http://www.westernclimateinitiative.org/

[7] http://www.arb.ca.gov/cc/forestry/forest_scoping/forest_scoping.htm

Forest strategies to further reduce emissions

Birdsey et al (2006)[8] identified a number of forestry approaches that could increase GHG benefits. The Climate Action Team incorporated these ideas into the 2006 Climate Action Team report by identifying five basic forestry strategies for reducing greenhouse gas emissions. We used and expanded on these categories as a start for the Forest Sector Scoping Plan. Strategies include:

1. Reforestation
2. Forest conservation
3. Forest management
4. Urban Forestry
5. Fuels Management/Biomass energy

The five forest strategies are broad enough that they encompass most, but not all, of the opportunities available through forest land management activities. These are centered on management actions applied to individual or groups of forest stands. These activities include tree planting, proper selection of tree species adapted to the site where planting will occur, commercial thinning, pre-commercial forest thinning, tree removal to improve forest health, increasing forest stand rotation length, fuel hazard reduction projects which remove fuel ladders, and in some infrequent cases direct action for pest management.

Some work is ongoing in each of the five areas. Full implementation, however, is contingent on additional resources or incentives, such as state funding, voluntary carbon markets, regulatory emissions trading markets (alternative compliance mechanisms), carbon taxes or fees, renewable energy tariffs and incentives, assistance programs, fee-based tariffs, and changes to CEQA.

While providing a significant framework, these categories are probably not comprehensive. Activities which don't fit into these categories include, for example, a) substitution of wood products for more energy intensive building materials and b) the general issues of wood product consumption and importation.

Substitution is a term that applies not only to construction, but also to areas such as energy. Wood is currently used to produce heat for residential and commercial purposes and well as electricity. An extensive effort is currently underway to develop a commercially viable process to convert cellulosic materials to fuels for transportation and other uses. The advantage to using wood in place of fossil fuels is still under study due to the amount of variations in processes used in producing the energy, and the type of energy being replaced.

Wood product importation provides ~80% of the wood products used in California. Increasing the percentage of wood products provided from in-state timber harvests can add to the GHG emission reductions of the State. Support of such significant volumes of wood importations only transfers forest harvesting-related GHG emissions from California forests to forests in other states and countries. This leakage of forest-related emissions needs to be addressed.

[8] Birdsey, Richard A.; Pregitzer, Kurt; Lucier, Alan. 2006. Forest carbon management in the United States: 1600-2100

Federal lands involvement in future activities

The Chief of the USFS made a commitment in 2008 to double carbon sequestration on USFS lands by the year 2020. Each Federal land management agency will have to make independent policy commitments. This will require the State to maintain close coordination with its federal counterparts (ie. state and national parks). There is no clear executive branch policy regarding federal lands involvement in carbon sequestration activities. If federal land management agencies are to participate, each federal land management agency operates under a unique authorization, mandate and mission.

The USFS and BLM are the most likely agencies to be able to deliver under forest protocols involving active forest management such as reforestation, conservation forest management and fuel hazard reduction. The principles of baseline, permanence, additionality, leakage and verification will have to be examined and redefined for public lands before their role can be more clearly defined. The CCAR Working Group is currently examining these principles for consideration and public dialog. The USFS can currently contribute to urban forestry and conservation activities through their State and Private Forestry programs. The NPS could possibly participate in Fuel Hazard reduction activities, however CCAR deliberations apply to them also.

Economic Analysis of Opportunities

Brown (2004)[9] estimated the potential for implementing forest and rangeland management in California to increase GHG benefits, based on land use and potential carbon production. Summarizing the results in terms of carbon price points, they concluded that for $50/ton carbon ($13.6/ton CO2), 300,000 acres could be managed to lengthen harvest rotations for a benefit of 2 to 3.5 million tons CO2, and over 40,000 acres of increased riparian buffers could be established to produce almost 4 million tons CO2 benefit in a 20 year period. They also concluded that 200,000 to 12 million acres of rangelands could be afforested or reforested over a 20 year period, producing 33 to 887 million cumulative CO2 tons at price points ranging from $2.7/tC ($10/t carbon) to $13.6 tC (Brown et al 2004). Case studies on private and public lands are underway as part of the WESTCARB phase II project and the Alder Springs Fuel Hazard Reduction Stewardship Project. The USFS in California is conducting an analysis of carbon sequestration capabilities. Forest landowners are also conducting their own analyses. Results from these studies should assist in improving estimates of state-wide potential of forest carbon sequestration.

11) How were emission reduction measures developed or evaluated?

Four public stakeholder meetings were held. Two general informational meetings were held: one in November 2007, one in January 2008. Two workgroup meetings were held in February 2008, to go over measure details and solicit specific stakeholder input. Throughout this timeframe, ARB, CalFire and

[9] Carbon Supply From Changes In Management of Forest, Range, and Agricultural Lands of California. Brown, Sandra. CEC-500-2004-068F.
http://www.energy.ca.gov/pier/project_reports/500-04-068.html

Resources Agency led these meetings and explained the process through which stakeholder input would be solicited, how input would be integrated, and our expectations of stakeholders. As a part of the CAT macroeconomic analysis, CalFire had previously analyzed and quantified10 measures. The stakeholder process elicited 35 more measures, only three of which quantified reductions from forest sector activities. The Technical Team analyzed several of these and forwarded two to ARB plus expanded two analyses from the CAT report. All stakeholder suggestions are, however, included in the appendix to this chapter.

12) Ensuring real, permanent, quantifiable, verifiable, and enforceable reductions

The definitive measure of success for the sector in meeting AB 32 targets will be the maintenance or net increase in sector-wide carbon stocks. The change in carbon stocks, including full life-cycle considerations, will encompass the flux associated with growth, harvest and mortality occurring both within and outside of carbon projects. This will address the issue of fundamental concern, greenhouse gas concentration effects to the atmosphere.

Specific strategies will be monitored using appropriate metrics (i.e. acres, number of trees, CO_2e tons) with enforcement through voluntary and offset markets using accepted protocols. CCAR has protocols for forest conservation, management and reforestation that have been adopted by ARB. Revisions to reduce the costs and broaden participation while maintaining protocol integrity are underway in 2008. The protocols require third party verification. Projects undertaken outside of the protocols will be tracked on a programmatic basis and all areas will be included in the top down inventory.

A shortfall in a specific measure may be made up directly by another measure or, indirectly in the context of the sector-wide inventory, without a specific measure. Projects using protocols either in a voluntary or offset market context will have the supplier contractually obligated to deliver carbon tons. A shortfall will require the supplier to purchase the tons on the market. Climate change may induce emissions over time through gradual vegetation type conversion or catastrophic releases due to wildfire or pest outbreaks. In this context a minimizing of emissions through adaptation may become the goal.

Activities outside markets may require top-down or voluntary bottom-up monitoring and reporting, or some combination thereof. This will likely require state funding for landscape scale monitoring (e.g. high level imagery and interpretation such as Landsat or LIDAR).

13) Existing controls resulting in emission reductions and co-benefits

As applied to the forestry sector “control measures” refers to regulatory or other federal, state or local programs that have led to GHG reduction or co-benefits (Table 1).

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Table 1. Existing Forest Sector Control Measures

Strategy for Sector	Existing "Control Measures"	Benefits Quantified	Co-benefits not quantified
REFORESTATION	Federal policy and budget State grants and cost-share programs	Carbon sequestered	Better forest health Water quality Wildlife habitat diversity Improved air quality More bio-energy
FOREST MANAGEMENT	Federal policy and budgets Forest Practice Act and other State laws State and federal laws State grants and cost – share programs	Carbon sequestered	Better forest health Reduced fire hazard Water quality Wildlife habitat diversity Improved air quality More bio-energy
CONSERVATION	Conversion permits CEQA application Local land use ordinances State propositions, budget, grant funding Federal grant funding	Avoided emissions from conversion Carbon Sequestered	Better forest health Water quality Wildlife habitat diversity Improved air quality Recreational opportunities
FUEL REDUCTION AND BIOMASS	Federal policy and budgets State budget, funding, and grant programs	Reduced emissions from wildfire Production of electricity and biofuels	Better forest health Protect wildlife habitat and diversity Reduce peak storm runoff and downstream damage to property from floods Lessen transport of sediment to water storage facilities
URBAN FORESTRY	State and federal grants	Carbon sequestered Reduced electricity consumption Production of electricity	Slow storm water runoff Wildlife habitat Increase property value Extend life of asphalt pavement Improved urban lifestyle

14) Early Action Measures, Discrete Early Action Measures, CAT Early Action Measures

ARB adopted the CCAR Forest Protocols as an Early Action measure. To date, two projects have been certified by CCAR and others are pending. Updates to these protocols to induce greater participation, especially by public lands, are scheduled to be adopted in early 2009.

CAL FIRE has continued to implement fuel hazard reduction projects since December 2005 at a rate of 25,000 acres per year. CAL FIRE has not yet attempted to quantify the amount of wildfire emissions avoided by implementing these projects.

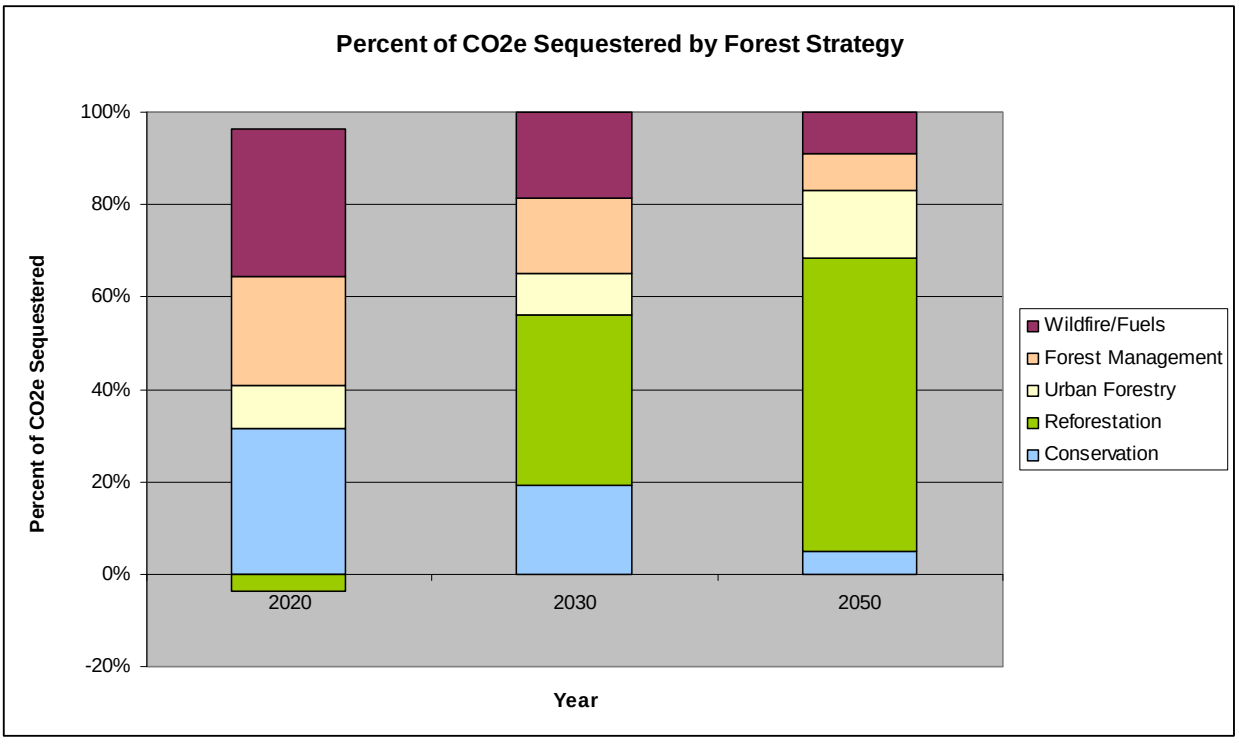
15) Public Solicitation Measures

Where possible, measures received in response to ARB's October 2007 solicitation that were quantifiable were analyzed. The quantifiable ETAAC measures had been taken from the CAT Macroeconomic Analysis and thus were de facto included. These have all been discussed earlier.

16) Expected reductions from the overall sector approach

Through implementing all proposed measures the forest sector can be expected to reduce emissions or sequester carbon at an annual rate of 8 MMTCO2e in 2020 and 27 MMTCO2e in 2050. The largest total GHG benefits in 2020 in the forestry sector comes from fuels management due to biopower benefits, although these would be counted in the energy sector. The next highest reductions come from forestry management, mostly from regulations enacted in 2005, and then forest conservation. Sequestration benefits from reforestation and urban benefits, though low in 2020, increase dramatically in later decades. If reforestation implementation starts now, annual reductions reach 7 MMT CO2e in 2030 and 24 MMT in 2050.

Figure 2 – An estimate of the relative contribution of each forest strategy to CO2 sequestration.



17) Public health effects—Effects on air quality

Collectively, all the forestry measures have potential long-term health benefits from the mitigating effects of planting trees in rural and urban areas. Through expanded tree planting in cities the proposed measures under Urban Forestry should improve air quality and have many beneficial effects for public health. These include reduction in air temperature, removal of air pollutants, and

reduced energy demands from homes and office buildings. Over, time as urban trees mature the capacity for trees to filter air pollutants and improve air quality increases.

The primary source of air quality emissions from the forest sector are associated with wildfires and prescribed fire. Fuel combustion results in emissions of gaseous air pollutants, such as CO, CO2, Reactive Organic Gases (ROGs), SO2, and NOx. Emissions from fire result in both PM10 and gaseous emissions, although PM10 emissions are the most significant effect. The chemistry of the fuel as well as the efficiency of combustion governs the physical and chemical properties of the resulting smoke from fire. Air quality impacts due to fire emissions are affected by both the quantities of fuel consumed and by the prevailing weather conditions. Approaches to minimize emissions from wildfires would include: (1) minimize the area burned, (2) reduce the fuel loading in the area to be burned, (3) reduce the amount of fuel consumed by the fire, (4) minimize emissions per ton of fuel consumed.

The proposed measures for forestry include increasing state efforts to reduce high fuel loadings. These efforts will not eliminate wildfires, but will reduce the amount of fuel consumed and should also reduce the extent of the area burned. The combined effect should result in a reduction in air quality emissions from wildfires. There is also the potential for some short term increases in air emissions if prescribed burning is used more extensively as a fuel reduction treatment method.

18) Environmental justice impacts

Environmental Justice has been considered for the Forest Sector from the beginning of the public deliberations on Climate Change by both the California Climate Action Team and the Air Resources Board (ARB).

Topics which need consideration for the Forest Sector are:

- The Environmental Justice Committee has deep concern about the appropriate use of forest-based carbon sequestration and its potential as a long term solution for meeting California's GHG reduction targets.
- The use of chemicals in forest management activities.
- The use of offsets to permit continued pollution by regulated sectors.
- In urban areas tree plantings should be appropriately distributed to all communities.
- Fire suppression efforts should be equal amongst all communities threatened by large damaging wildfires.

There is some concern that tree planting under CAL FIRE's Urban Forestry program may not be evenly applied to all communities. This is addressed in guidelines used by CAL FIRE for Urban Forest grant application and awards.

Fire suppression is conducted to minimize the overall impacts of large damaging wildfires. Suppression activities are not sensitive to community composition areas being threatened by these wildfires.

Forestry is a highly regulated activity in California. The harvesting of timber is directly regulated by the California Forest Practice Act and Rules. This regulatory framework includes compliance with CEQA and EJ considerations. Other

compliance requirements for air quality, water quality, and endangered species are applied by the appropriate state and federal agencies. In all of these processes public disclosure and participation is a mandate.

Identified impacts to small business would be positive. Historically, there was a large infrastructure of timber operators and other occupations related to woods operations. However, for a variety of reasons, the number of operators and infrastructure supporting logging and other forest operations has declined substantially. Many operators were small businesses. Increased activity related to forest management, reforestation, fuel reduction projects, and even urban tree planting and maintenance probably will result in an increased demand for equipment and operators. This demand could lead to the creation of new small businesses and the retooling of others. A small positive impact also will result as businesses that bundle and sell carbon offsets develop. This bundling of carbon credits will increase the amount of product available on the market.

19) Additional considerations

The concerns which have emerged in all the forest sector discussions include the need to assure that reductions are real, quantifiable, additional, and permanent. The requirement of additionality necessarily imposes in each measure a need for a robust and consistent baseline. The choice of that baseline affects the size of reductions that are achievable. Baselines are defined for projects at the small scale using a CCAR protocol, but at a larger programmatic scale, baselines have yet to be defined. Furthermore, when an action achieves a reduction because it helps to avoid an emission (eg., deforestation, development, wildfire), the baseline of “what would have happened, but for the action” is very difficult to determine. In fact, such discussions are the source of much international discussion.

The issue of tracking emission reductions has also emerged in discussions. How will progress be tracked and account for the success or failure of these proposed measures? How will we know if we have achieved the desired reductions? An intensive monitoring plan is proposed for development to address these issues.

Most of the forest lands in California are in federal jurisdictions. The USFS manages the bulk of forest lands in California. Developing strategies which include and incentivize reductions on federal lands will be key to including the forest sector in an overall reduction plan.

Because forests are ecological systems with multiple functions within a greater ecosystem, an important concern is that these ecological functions not be impaired by the development of carbon-centric programs. Generally, programs that conserve forest land and maintain healthy forest ecosystems for carbon benefits also benefit other ecological functions. However, this isn’t always true. An example is the suppression of fire. Fire can create large GHG emissions, leading to proposed programs to suppress fire or manage forests to reduce fire. However fire is also an integral and healthy part of many forest ecosystems. Many ecosystems are dependent on fire.

Finally, although the goal of the Scoping Plan is mitigation, forests are already being affected by climate change. Including plans for adaptation should be an important and intelligent component of the mitigation program.

A key part of these programs should be the concept of adaptive management: the implementation of measures and programs with an eye toward monitoring outcome, and the willingness to shift direction midstream if the outcome is deemed unacceptable. We can't know all the interactions, conflicts and outcomes at the beginning of a program, but through monitoring we can become aware through the process of implementation. This requires a framework of monitoring, multi-directional communication, and quick response.

Summary and Conclusions

Forests play a significant role in the carbon cycle and in mitigating the effects of climate change. Through photosynthesis trees remove CO2 from the atmosphere and sequester carbon as wood. The forest sector is comprised of major carbon pools that include: biomass in forests, wood products in use, wood products in land fills, and bioenergy. The transfer of CO2 between forest carbon pools and the atmosphere is dynamic. Emissions from harvesting and wildfires, which can vary dramatically from year to year, are offset by forest growth, reforestation, and tree planting in urban areas. Currently, the forest sector operates as net carbon sink. With investments in forest strategies outlined, the current sink can be maintained and enhanced over time.

Climate change itself can affect biological and physical processes in the forest. Increases in temperature and CO2 concentrations in the atmosphere, along with the amount and timing of precipitation can affect the distribution and productivity of tree species. Hence both mitigation and adaptation strategies for the forestry sector are needed.

Climate benefits from some forestry measures, such as reforestation, will accrue slowly at first but if started now will provide large GHG reductions by 2050.

The forest sector interacts with several other sectors, such as land use, water and energy. Forest sector activities produce many additional environmental and economic co-benefits. Co-benefits are sometimes hard to quantify; but they are very important to consider in tallying the overall benefits of climate change strategies in the forest sector.

The management of forest sector lands by private, non-profit, and public and non-profit organizations will require a mix of incentives and other mechanisms to effectively implement the forest sector strategies. Regulatory coordination, non-regulatory governmental programs, volunteer efforts, and market-based programs will all be key in implementing measures.

Success of forest sector strategies depends on high levels of investment from the private and public sectors; this will require diverse programs and approaches. There are a wide range of choices and policy implications associated with implementing strategies in the forest sector, thus the cost of implementing individual measures is highly variable. Market based approaches, voluntary actions, and existing regulatory programs have relatively low costs; while substantial public funding may be required to increase reforestation, urban tree planting, and managing fuel loads to reduce emissions from wildfires.

Appendix

List of AI Proposed Forest Sector GHG Reduction Measures

Reforestation
- Reforestation – CFIP
- Reforestation - Offset Market
- Reforestation - Federal Lands
- Reforestation - State Lands

Management
- Riparian Buffer Extension by 200 ft
- Changes to Forest Practice Rules
- Address barriers in forestry assistance programs for non-industrials
- Aggregation of small landowners
- Working Forest Easements
- Ownership/Landscape-level mgt. plans
- Additional forest management improvements, such as extended rotations and thinning
- Replanting prior to the 10 year limit
- Forest Management on Public Lands
- Stimulating improved mgt. on non-industrial forest land through alternative regulatory path
- Increase thinning on non-reserved federal lands by 500k ac/yr (CFA)
- Medium to long-term carbon contracts
- Under-utilized (under-stocked) forest – enhance activities to improve stocking and planting on under-utilized forest stands
- Limit even-aged silvicultural methods to reduce emissions from even-aged forest management

Wildfire/Fuels
- Fuel reduction projects
- Prescribed Fire
- Fire Prevention
- Risk-based Insurance Fee Structuring
- Increase federal lands fuel treatment by 500k ac/yr (CFA)
- Post-fire treatments

Biomass
- Bioenergy action plan

Conservation
- Prop 84 - forest conservation
- Prop 40/50 - forest conservation
- Offset and mitigation banks
- Landowner consortium
- Land Use Planning
- NGO and local government programs
- Public/Private Partnerships
- Incentives for landowners to keep land in TPZ to gain carbon benefits of slowing the rate of land being converted from TPZ

Urban Forestry
- Tree Planting - Biopower
- BMPs for local government
- Tree Planting on private property, funded by utilities
- Increase tree ordinances
- Tracking of Voluntary Planting

Cross-cutting
- Forest sector public goods charge and incentive-based regulatory framework
- Communication/Education/Outreach
- Construct to facilitate communication between state and county
- Accelerating the implementation of current fire avoidance building regulation
- Research and pilot projects
- Use of CCAR protocols
- Third-party review of projects

Other
- A requirement to provide supporting documentation for all proposed measures

Climate Action Team
Forestry Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

The purpose of this document is to provide the public with information about options considered and analyzed by the Climate Action Team (CAT) Sector Sub Groups for Air Board's consideration and potential inclusion in the Scoping Plan. This information should be drawn from the Measure Analyses previously developed by each Sub Group.

Information should only be updated to reflect significant changes in technology, staff assignments, and understanding of the issues.

Outline

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Climate Action Team

Forestry Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

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1. Measure: Conservation Forest Management

2. Agency: California Department of Forestry and Fire Protection

3. Measure Description

Overview

For the purposes of this document forest means those areas that have or are capable of supporting a tree canopy cover of greater than or equal to 10% of the area. Conservation forest management entails a wide variety of practices that can be applied to a forest stand, ownership or landscape that changes the current vegetative cover composition, structure, or arrangement. Examples of forest management activities include:

- Optimizing the number and species of existing trees growing on the land to fully capture growth potential,
- Buffer strips along watercourses where a greater number of large dominant and co-dominant trees are retained on a permanent or longer term basis,
- Inter-planting trees within an existing stand of trees to ensure that the biological productive capacity of the site is more fully utilized,
- Removing competing vegetation in young forest stands such as brush or hardwoods to increase the rate of growth of the remaining trees.
- Managing the crop trees to optimize carbon sequestration potential (maintaining rate of growth, tree genetics, rotation age, reduced risk of disturbance).
- Actions to control a disease or insect infestation

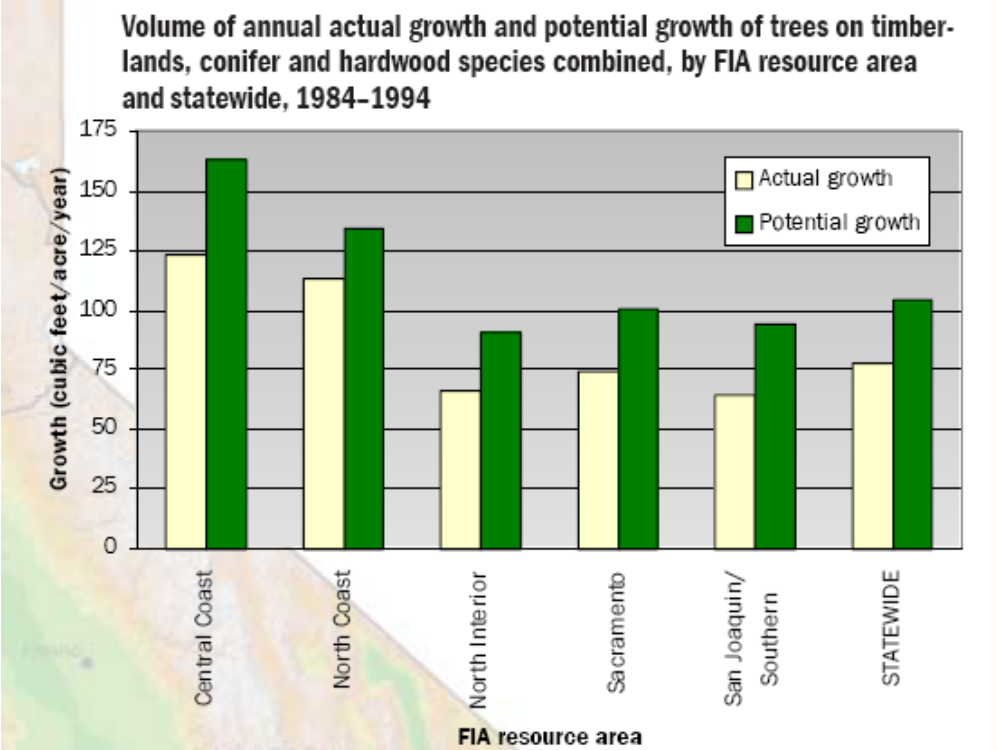
Conservation forest management can be applied at the stand, ownership, watershed, or landscape level depending upon the conditions under which the manager is working. The size and arrangement of forest ownerships vary from small (<3 acres) to very large (> 1,000,000 acres) in California. Smaller ownerships may have more intensive management, thus maximizing the potential amount of carbon stored on each individual acre. Larger ownerships will tend to apply management practices that increase the average amount of carbon stored per acre on a planning watershed basis (California Code of Regulations, Title 14, Division 1.5, Subchapter 1, and Section 895.1). Small ownerships require more technical assistance and support by consulting foresters or the Department as the owners will likely have limited resources of their own. These smaller owners will also have more limited financial resources and may require a greater level of cost share assistance. Larger ownerships will most often

have professional foresters and a greater financial base from which to invest in forest improvement practices. However, these owners will need to be assured they will regain sufficient income from their forest management practice to warrant the investment.

The purpose of the Conservation Forest Management Strategy is to increase and maintain total carbon stocks on an ownership over time. This approach accounts for the landowner's planned actions such as harvesting, forest improvement projects and natural disturbances. The activities are planned and implemented such that there may be declines in the total carbon stocks at a point in time. However, on the longer term planning horizon the carbon stocks for the ownership(s) will result in an increase. The carbon stocks in California also must be managed to consider other constraints such as water quality protection, endangered species protection, wildlife habitat diversity, and air quality. These constraints will dictate that not all acres are managed for the maximum potential carbon storage. The art and science of forest management is to reach and maintain the forest landscape in a condition that provides the optimal balance amongst this mix of social and ecological objectives.

Due to changes in the federal forest inventory procedures, there are numerous differences between the ongoing inventory with previous ones. Comparison of previous and current inventories will not produce valid estimates of change. Attempts to estimate annualized net change in inventories over the recent decade have large sampling errors. For this reason and for purposes of illustration, statistics of the previous California forest inventory are used.

Using USFS data from the period 1984-94, the potential of forest management to contribute to the reduction of greenhouse gases, primarily carbon dioxide, is captured in "The Changing California, Forest and Range 2003 Assessment" (Assessment). Though these estimates are old they are representative of the potential forest management provides for increasing carbon storage. It is estimated that for most ownerships statewide forests are growing at 70 to 75% of their potential. From a statewide level for all lands it is estimated that the total growing stock is approximately 55 billion cubic feet with an approximate average growth rate of 2.4% per year. Using those numbers, the approximate annual growth for California forests is 1.32 billion cubic feet per year and has the ability to improve the growth potential by 25 – 30%. This equates to a potential increase in annual growth to a level of 1.76 to 1.88 billion cubic feet per year. That would be an annual increase of .44 to .56 billion cubic feet per year. Using an average dry weight of wood at 25 pounds per cubic foot (Forest Handbook second edition) then each cubic foot represents 12.5 pounds of carbon or 45.8 pounds of carbon dioxide. If specific management efforts are taken to capture this unrealized growth, this translates into a potential annual increase of carbon dioxide in the range of 10.1 to 12.8 mmtCO_2 per year. This estimate would be constrained to something less than the potential due to institutional and social barriers as well as biological and technical limitations.



For the purposes of this discussion on the potential to increase carbon storage, California has three basic classes of forest landowners. They are the *Public Landowners*, *Industrial Timberland Owners*, and the *Non-Industrial Timberland Owners*.

The carbon storage potential previously described does not include some actions already being taken by some portion of the State's forest landowners. The carbon stocks put forth in the Air Resources Board Forest Sector GHG Inventory include carbon that has been stored through actions that are over and above the business as usual standards of the Forest Practice Act and rules. An example of this is cited in a stakeholder communication from the Forest Landowners of California (2008) that reviewed 8 non-industrial timber management plans. These plans cover management of 8564 acres and show that, conservatively, forests will sequester about 2 tons of CO_2 per acre per year voluntarily; this is in addition to CO_2 sequestered because of regulations.

The non-industrial timberland owners offer a large opportunity for increasing carbon storage. This class of landowners has an approximate 4.6 million acre land base. Some landowners have invested in a more aggressive forest management approach while others have chosen to apply forest management that results in either a maintenance of or decrease in carbon stocks. Development of a carbon market may be sufficient to entice these landowners to invest more aggressively in forest management actions that would increase the carbon storage on their lands. The landowner class between the maximum NTMP size of 2,500 acres and the minimum size for large landowners of 50,000 acres may benefit from regulatory incentives to sequester more carbon.

In addition, the forest industry has about 4.4 million acres of timberland. Commonly the forest industry seeks to improve the growth of its forests through use of improved genetic stock,

increased site occupancy, reduced hardwood competition, and replacement of slower growing stands of trees. Such actions translate into more growth per acre per year and ultimately more frequent timber harvests. Absent the actions of these landowners the lands they own would be storing carbon at a slower rate. This growth rate also adds to the amount of wood products produced on an annual basis and results in more carbon being stored in long-term wood products. However, the forest industry has not applied this management to all of its acres. Many of the acres of an ownership have a lower biological potential for growth (soils, available moisture) and with timber value alone; investments in aggressive forest management are not justified. If there were value added from a carbon market for investing in these lands with a lower productive capability, landowners could benefit from the ability to invest in improving the management of the lands with lower productivity (increase carbon storage)

The Department did not complete a full analysis of the potential carbon gains for Conservation Forest Management. The timing on this scoping plan process did not provide sufficient time to complete analysis of the potential gains in forest management from the thinning of overstocked stands or the benefits gained through voluntary carbon added with the use of long-term watershed level management plans. A separate measure provided by the Forest Landowners of California on the Non-Industrial Timber Management Plan gives an indication that these larger management plans provide a significant opportunity to increase carbon storage. The Department intends to continue looking at this potential and include the measure (or similar measure) in the June update period for this process.

Affected Entities

The affected entities for Conservation Forest Management are very broad:

- Private Landowners: industrial and non-industrial landowners will be encouraged to voluntarily add forest management practices that will increase carbon storage. The primary encouragements will be technical and cost share assistance for small landowners (< 5,000 acre ownerships). The primary encouragement for the large landowners will be the development and implementation of a carbon market. Regulatory actions by the Board of Forestry and Fire Protection (Board) and other responsible agencies such as the Regional Water Quality Control Boards and the Department of Fish and Game will also have an impact on increases or decreases in carbon stocks on an ownership.

- Public Landowners: approximately ½ of the timberlands in California are under public ownership including the United States Forest Service, National Park Service, Bureau of Land Management, Bureau of Indian Affairs, Bureau of Reclamation, State Department of Parks and Recreation, State Lands Commission, Cal Trans, Department of Water Resources, Department of Water Resources, Department of Fish and Game, Wildlife Conservation Board, and the Department. Much of the increased carbon storage on California forest lands since the mid 1980's has occurred on federal ownerships. This is primarily due to a shift in management objectives to non-commodity values.

- Regulatory Agencies: forest management in California has been a contentious issue since the mid 1970's and the enactment of the 1973 Z'berg – Nejedly Forest Practice Act and subsequent rules. Agencies with regulatory responsibilities related to forest management on private lands include, State Water Resources Control Board, Department of Fish and Game, State Geologic Survey, Air Resources Board, Coastal Commission, Native American Heritage Commission, County Governments, National Marine Fisheries Service, Fish and Wildlife Service, and the Federal Environmental Protection Agency. These agencies may enact additional regulations or may identify

impacts requiring mitigation on forest management projects through the California Environmental Quality Act processes.

- Non-Profits: California has numerous non-profit organizations that are involved with management of rural and urban areas. Examples of these organizations are The Nature Conservancy, Conservation Fund, Pacific Forest Trust, and a variety of organization representing professions that practice on the landscape. For example Pacific Forest Trust has been working at obtaining landowner participation in easements that pay landowners for the development rights on tracts of forest lands. A recent success in this area is a 10,000 acre forestland ownership near Mt. Shasta on the McCloud River.

Environmental Justice, Small Business, Public Health, Leakage and CEQA

Environmental Justice has been considered from the beginning of the public deliberations on Climate Change by both the California Climate Action Team and the Air Resources Board (ARB). Subsequent to the issuance of the 2006 Climate Action Team Report the State Legislature passed AB 32 (The Global Warming Solutions Act) and the Governor signed the bill. AB 32 became effective January 1, 2007. The bill carried Environmental Justice forward as an interest to be addressed in each of the major emission sectors. Forestry is one of those sectors. ARB established an Environmental Justice Advisory Committee (EJAC) as required by AB 32. This committee has had numerous meetings that have been advertised on the ARB website. Forestry Sector concerns were discussed in these meetings.

A set of public meetings addressing the Forest Sector were held in February 2008 for the AB 32 Scoping Plan. These meetings were also advertised on the Website to invite public participation. No Environmental Justice Issues were raised during those meeting.

EJAC raised one specific comment in recommendations on ARB Early Actions. Other possible concerns for the Forestry Sector are also listed below. Topics which need consideration for the Forest Sector are:

- The Committee has deep concern about the appropriate use of forest-based carbon sequestration and its potential as a long term solution for meeting California's GHG reduction targets.
- The use of chemicals in forest management activities.
- The use of offsets to permit continued pollution by regulated sectors.
- In Urban areas tree plantings should be appropriately distributed to all communities.
- Fire Suppression efforts should be equal amongst all communities threatened by large damaging wildfires.

The concern that the use of offsets (including forest offsets) will permit continued pollution by regulated sectors is not completely addressed. This issue is still under discussion by the participants in this and other processes. One possible outcome would be some restriction on what the offsets could be used for. Example, if forest sequestration offsets were only allowed to offset Carbon Dioxide, then the criteria pollutants and other harmful substances would have to be dealt with through other mechanisms such as reductions through technology.

There have been repeated concerns expressed about the use of herbicides in forest management activities and the potential impacts on the waters of the state and Native American vegetation gathering. Forestry projects have several safeguards in their development and implementation for the use of herbicides. The use of the chemicals themselves are regulated by the County Agricultural Commissioners and are only applied in accordance with strict label restrictions developed by the federal EPA. The Regional Water Quality Resources Control

Boards both permit and require monitoring of the use of forest herbicides. The California Department of Forestry and Fire Protection conducts either programmatic or project-by-project analysis or mitigation of the use of herbicides under the requirements of the California Environmental Quality Act (CEQA). Together these agencies and processes foster the safe use of herbicides in forest management activities.

There is some concern that tree planting under the California Department of Forestry and Fire Protections (Department) Urban Forestry program may not be evenly applied to all communities. This is addressed in guidelines used by the Department for Urban Forest grant application and awards.

Fire Suppression is conducted to the overall impacts of large damaging wildfires. Suppression activities are not sensitive to community composition areas being threatened by these wildfires. Firefighter and public safety are of the highest importance during wildfire suppression. At the same time, smoke and other pollutants can be blown by the wind across communities distant from the actual fire. Poor quality air due to wildfire can aggravate lung and other diseases, as well as lessen the quality of life of every citizen in the smoke's path. For this reason, from an environmental justice standpoint, it is paramount to have rapid control of wildfires.

Similarly, use of prescribed fire can reduce fuels and the risk of wildfire, but can have adverse air quality impacts over a large area. For this reason, use of the practice is limited to days where atmospheric conditions will dissipate smoke. Other restrictions also are imposed by forestry and air quality agencies.

Forestry is a highly regulated activity in California. The harvesting of timber is directly regulated by the California Forest Practice Act and Rules. This regulatory framework includes compliance with CEQA. Other compliance requirements for air quality, water quality, and endangered species are applied by the appropriate state and federal agencies. In all of these processes public disclosure and participation is a mandate.

These same regulatory processes provide an additional avenue to address environmental justice concerns. These concerns are often related to impacts that may occur from project-related environmental impacts. An example would be the previous discussion on the potential environmental and environmental justice impacts related to the use of herbicides in forest management projects.

Identified impacts to small business would be positive. Historically, there was a large infrastructure of timber operators and other occupations related to woods operations. However, for a variety of reasons, the number of operators and infrastructure supporting logging and other forest operations has declined substantially. Many operators were small businesses. Increased activity related to forest management, reforestation, fuel reduction projects, and even urban tree planting and maintenance probably will result in an increased demand for equipment and operators. This demand could lead to the creation of new small businesses and the retooling of others. A small positive impact also will result as businesses that bundle and sell carbon offsets develop. This bundling of carbon credits will increase the amount of product available on the market.

Related Objectives

The strategy is motivated by multiple benefits. Conservation Forest Management, as with Afforestation and Reforestation, provides other benefits through improved water quality, wildlife

habitat diversity, improved air quality, expanded bio-energy opportunities, and jobs. By applying various forest management activities the landowner is developing and maintaining a healthy forest that provides all of the associated economic and ecosystem service benefits. Many of the forest management activities involve the removal and sale of trees or parts of trees. This material is used to produce a variety of products such as boards, plywood, particle board, paper, energy (fuels & electricity), and wood based chemical products.

Measure Metrics

The metrics for carbon benefits resulting from forest management activities are provided in the Forest Protocols published by the California Climate Action Registry, or in a publication by the California Energy Commission titled "Methods for Measuring and Monitoring Carbon Projects in California, Winrock International, 2004" (http://www.energy.ca.gov/pier/final_project_reports/500-04-072F.html).

A summary of the metrics for this strategy is expressed in acres and tons of carbon or carbon dioxide.

Measure Goals and Potential Implementation Approaches

The strategy states the intent to sequester 2-4 million tons of CO_2 annually by 2020. In 1991-92 the rules of the Board were amended to change the methods and timing of permitted timber harvesting. Before this rule amendment harvesting on private timberland could be conducted at a level where the rate of harvest exceeds the amount of growth over time. The Forest Practice Rules established a regulatory minimum stocking standard for unevenaged management and a minimum rotation age for evenage regeneration. The Forest Practice Act along with the revised Rules of the Board basically establishes a basis from which additionality is measured.

By increasing forest growth through managing the level of stocking and fully utilizing the site where stocking has been reduced due to fire, insects, disease, failed conifer reforestation or other factors, there are significant opportunities to increase the carbon storage available over the next few decades. Many of the timberland owners in California have made voluntary choices to manage their forestlands at a level above the minimums of the Forest Practice Act and Rules. Some actions taken by this portion of the forest landowners include 1) plant trees where full biological potential is not met, 2) thinning trees where overstocking exists, 3) commercially thin from below leaving larger faster growing crop trees, and 4) restoring conifers to riparian and other areas dominated by hardwoods. Other timberland owners have opted to replace existing stands of trees where repeated harvesting has resulted in conditions such as reduced genetic quality, poor species composition, or poor rates of growth. This voluntary choice of the landowners will be recognized as this strategy is implemented and documented. This is true for both industrial and non industrial timberland owners.

Following are implementation options that will be pursued. In this strategy there will need to be public investment and carbon market opportunities made available to realize the maximum opportunity for additional carbon storage:

Measures from Prior Macro-Economic Analysis and Quantified

- A market opportunity exists for the extension of the existing riparian protection zones required by the Forest Practice Rules. Existing riparian protection zones could be

expanded by fifty feet (50 ft.) At approximately \$20/tCO_2 there will be 0.26 MMT CO_2 available per year by 2020.

- The Board of Forestry and Fire Protection adopted regulations in 2004 which increased regulatory protection of existing riparian zones and added protection to previously unprotected riparian zones. This has been accruing carbon benefits and will continue to do so through 2020. The carbon benefits to 2020 have been calculated to be 33.55 mmt CO_2 or 2.23 mmtCO_2 annually for the 15 year period from 2005 to 2020. Potential benefits from these past regulatory actions were not carried out to 2050.

Measures Suggested by Stakeholders and Quantified –

Two Stakeholders meetings were held in February 2008 to gather public suggestions on measures that would add to the climate benefits expected from the Forest Sector.
CAL FIRE did not analyze or cannot recommend most of these at this time. The exception is the following market-based measure for timber stand improvement .

"Carbon Market – Timber Stand Improvement" - Several forest management activities that would provide increased carbon storage were suggested by the stakeholders. All of those activities are currently being used by landowners but only where the market value of timber or other considerations currently justify investment in those actions. These activities include 1) removing hardwoods and increasing conifer stocking, 2) thinning stands to increase the growth rate for remaining trees, 3) optimizing rotation age from a carbon life cycle perspective, 4) planting additional trees where the existing stocks are not fully utilizing the biological potential of the site. These activities are all being considered as a Carbon Market measure. These activities together are referred to as Timber Stand Improvement activities. The additional value of the carbon will provide the incentive for the private landowners to make the additional investment in their lands to better utilize the growth potential.

Currently there has been approximately 24,000 acres of conservation forest management projects recorded and verified using the CCAR Forest Protocols. These projects have sold some of the carbon from those projects at a price point near \$10/t CO_2. These projects have also taken place using the current criteria to establish permanence of that carbon. The current standard to establish permanence is the existence of a conservation easement agreed to by the landowner. A large segment of the stakeholders have stated that the conservation easement being used to establish permanence is a barrier to participation by a majority of the private landowners and all public landowners. CCAR and ARB recognized this when the existing protocols were adopted by ARB late in 2007. CCAR has initiated a review of the existing Forest Protocols which is intended to address this question among others. Tools to establish permanence will be developed during this process. Those tools will be consistent with or exceed the standards used to guarantee permanence in the international carbon markets. In addition, this protocol revision will provide a forest management protocol that may be used by public landowners. These changes have the potential to significantly increase the interest in the current voluntary market and any subsequent regulatory offset markets.

Relative to other measures, implementation of forest management practices is relatively inexpensive. This should increase the likelihood of participation in forest management, especially if carbon values are attached. We estimate that level at 40,000 acres of new projects a year from 2010 forward to at least 2020 and likely to 2050. With that in mind we expect an accumulation of 220, 193 tCO_2/year at 2020; 893,381 tCO_2/year; and at 2050 1.12 mm tCO_2/year. As timber stands age further out into the future the rate of gain for additional carbon shrinks until any new additional carbon is offset by tree mortality and natural decay rates. So at

some point after 2050 when the level of landowner participation has reached its maximum there will be a natural cap on new carbon stored.

Measures Suggested by Stakeholders – Not Quantified –

The following suggested measures were not analyzed or recommended at this time.

- Aggregation – A recommendation was offered to provide a mechanism that would allow smaller landowners to account for carbon benefits and then pool multiple ownership carbon accounts to provide larger blocks of verified carbon emissions for sale on the existing markets. This was examined and it was determined that the States Resource Conservation and Development Districts are well suited for such an effort and possess the institutional capabilities to do such work for the landowners. Approximately 3.2 million acres of timberland are in ownerships of less than 5,000 acres (http://www.buckeyeconservancy.org/pdf/ntmp-final-report.pdf). This is a significant block of forestland where conservation forest management projects could produce carbon benefits.
- Landscape Level Management Plans – The Forest Practice Act and rules allow for the development of landscape level management plans such as the Non-Industrial Timber Management Plan (NTMP) and the Programmatic Timber Environmental Impact Report. The initial purpose of these documents is to do a high level environmental impact analysis to address difficult issues such as cumulative effects. Completion of one of these documents reduces the scrutiny on subsequent individual Timber Harvesting Plans or Notices to Harvest, thus reducing the regulatory cost of timber harvesting. These plans are suited for inclusion of conservation forest management projects that would increase carbon storage for the ownership. A partial or full funding of the cost of preparation of these plans would provide landowners an incentive to include carbon storage projects. The current cost of an NTMP is within the range of $60 to 100 thousand dollars. Initial data has been provided by the Forest Landowners of California that suggests that management under Non-industrial Timber Management Plans does add significant carbon on a voluntary basis. This data is now being evaluated by CAL FIRE.
- Alternative Regulatory Pathway – Environmental Defense suggested an approach that would lessen the cost of regulatory compliance for landowners. This would act as an incentive for those landowners to include projects to increase carbon storage on their lands. This appears to be a similar suggestion to the “Landscape Level Management Plans” and the two ideas will be pursued together.
- Integrated Pest Management - This measure would utilize the current integrated pest management efforts to contribute to the maintenance of forest health and therefore a reduction in forest emissions either through primary pest or disease control, or secondary disturbances such as wildfire. Currently one of the major efforts in the state is the Sudden Oak Death Mortality task group.
- Ebbetts Pass Forest Watch submitted a measure to limit the amount of even aged forest management permitted under the Forest Practice Act. The premise was that even aged management results in carbon emissions as opposed to net carbon storage. The Department of Forestry and Fire Protection modeled a 100 year simulation comparing areas grown without harvest; areas harvested using unevenaged management, and areas using even aged management with intermittent thinning. These methods were compared showing the carbon accumulation per acre at the end of the 100 year period. Long-term wood products were included for the even and unevenaged management scenarios. The results showed that growing without harvest would have the most carbon per acre (142

tC/acre) with even aged management following (90.2 tC/acre), and uneven aged management having slightly less (79.5 tC/acre). When the carbon benefit of using of wood products in a substitution and displacement role for materials with larger carbon footprints was calculated evenaged management clearly provided more benefits than either of the other two options. The order of carbon benefits at 100 years was evenaged management (200 tC/acre); grown without harvest (142 tC/acre); and unevenaged management (141 tC/acre). Thus, it is not clear that the use of even aged management results in less carbon benefits from forest management over time.

- Barriers to Non- Industrial timberland owners – California has forestry assistance programs for timberland owners. These programs pay the landowner for a portion of the cost of reforestation and forest management activities. The landowners believe barriers exist to the use of the forestry assistance programs. The proposal suggests removal of the barriers would result in a much larger participation of landowners in the programs with a higher amount of carbon being stored over time as an added result. The barriers include an ownership size limit (5,000 acres maximum) for participation and intermittent funding. Historically when funding for these programs is available the funds have been fully committed.
- A significant portion of the industrial forest land and larger tracks of non-industrial forest land in California has done projections of what the standing inventory of tree boles will be over a 100 year planning horizon. These projections show that the landowners are voluntarily exceeding the regulatory standards of the Forest Practice Act. The Department believes that this is new carbon that should be counted towards meeting the states emission reduction standards. The Department has begun gathering the data to show what the total amount of this carbon contribution but was unable to finish the calculations before the due date of this report. The carbon accrued is a result of current investments for timber values so has no real carbon cost.
- A measure was suggested that the Timberland Production Zone (TPZ) tax law be amended to reduce the total tax burden for timberland owners. The concept was that this reduced tax burden would provide landowners with an incentive to defer and decisions to withdraw their ownership from TPZ and convert the land to non timber growing uses (deforestation). The Department was not able to determine a mathematical means of estimating these benefits.
- The Public Goods Charge measure to fund various forestry mitigation activities. Using the proponent's method of allocating revenues from the public goods charge, the additional funding to be made available for forest management activities would be approximately $7 million annually. If we assume the mechanical treatments for forest management are $1,000/acre, the additional funds would add a very conservative 7,000 acres per year to this strategy.
- The California Forestry Association suggested that by being more aggressive with its forest management the US Forest could sequester and additional 18 mmtCO2 annually without increases in cost. The Department has not had time to work with the USFS in evaluating the full feasibility of implementing this recommended measure and is not including the measure in these calculations. This will also receive further evaluation before the June opportunity to add further measures.
- Extended rotations and thinning
- Enhance underutilized and understocked lands
- Post-fire treatments to reduce emissions and enhance growth
- Research and pilot projects
- Additional protocols
- Third party review of projects

- Tracking and documentation
- Communication/education/outreach.

Measures from Prior Macro-Economic Analysis and Not Quantified-

- The State of California has significant landholdings, including substantial forested lands. Very little forest management has been applied to those acres with the exception of the Demonstration State Forest Lands (DSF). The DSF Land holding is approximately 70,000 acres. A small amount of that acreage has received timber stand improvement treatments (thinning, removal of competing vegetation, and interplanting of understocked areas where needed). In addition to managing the DSF the Department will work with the state agencies to identify other state lands where conservation forest management projects will increase long-term carbon stocks
- PG&E has recently been approved to proceed with a pilot voluntary tariff that would use ratepayer contributions (via monthly bill increases) to fund forestry projects that would increase carbon sequestration. The Department will work with PG&E to monitor the success of this program and encourage the other main utilities within California to develop similar programs. This program has recently purchased carbon tons certified under the CCAR Forest Protocols from two projects.
- Similar to the reforestation strategy, the state could provide landowners with tax credits for treatments that improve the carbon storage on forested acres. This will be done in coordination with the CAT.
- Work with the California Climate Action Registry and the Air Resources Board to modify the existing Forest Carbon Accounting Protocols to recognize the additional carbon sequestration provided by wood products once a tree is harvested and to develop additional forest protocols. CCAR and ARB have initiated a task group to complete a review and revision of three existing forest protocols
- Forest Management projects have been continually implemented in California over the last decade. The Department has begun to gather this information on activities that provide carbon benefits but are not developed as projects using the CCAR forest protocols. The Department will have a summary report on these activities available by January 1, 2015.

4. Technology

The technology employed under this climate change strategy is to alter the management of forests in a manner that increases the available carbon pools over time.

Management changes included here for carbon benefit are widened riparian buffers, past regulatory actions and use of the carbon market for Timber Stand Improvement activities. Timber Stand Improvement include management changes such as optimized rotations, thinning and pruning

Not considered in this report are the benefits of adjusting the density and species of existing trees growing on the land to optimize the rate of growth and overall biomass carrying capacity. For many potential Conservation Forest Management strategies additional research and analyses are required to quantify the costs and potential carbon gains of this activity.

Economic barriers exist to such changes in management and these will be overcome through expanding funding sources, changes in tax law and/or a carbon market which will monetize the carbon sequestration benefit of increasing the mean standing carbon stock.

5. Statutory Status

- The California Forest Improvement Program (CFIP) is authorized in Public Resources Code 4790 through 4799.04 and authorizes the Department to provide technical and other assistance (cost share funding) to private landowners with ownerships 5,000 acres and under. These lands have to have a 10% tree canopy cover or be capable of supporting such a tree cover. Some amendments of this set of statutes may be needed to allow use of state funds on larger private and public land ownerships.

6. Implementation Steps and Timeline

1. Forest Improvement Projects of State Land Holdings:
   a. The Department started identification of lands owned by other state agencies that are suitable for forest management projects in January 2007. There is some potential in this area and the Department of Parks and Recreation is developing a test forest restoration project following significant wildfire damage.
   b. The Department will continue making contacts with agencies that control land parcels that could benefit from forest management or reforestation projects.
   c. Beginning January 2008 the Department will begin to provide the technical assistance requested by those agencies to develop implementation plans for the forest management projects for the selected parcels.

2. Amendments to the CCAR Forestry Protocols allowing registration of wood product carbon sequestration values (This ties to reforestation and forest management protocols in that a harvest of planted trees is anticipated). Other revisions to the protocols are also being considered that would 1) expand the base of potential users, 2) reduce cost but maintain accounting rigor, and 3) enable the protocols to be used outside of California.
   a. The Forestry Protocols have had some minor adjustments adopted by the California Climate Action Registry in June 2007. The Registry is currently conducting further review to identify additional adjustments that will be made in 2008.
   b. The Department will work cooperatively with the Registry and ARB to develop the process to add wood products as a carbon pool which can be registered.

3. Documentation of Carbon already sequestered in past forest management projects:
   a. The Department has begun researching the amount of forest management that has been completed by landowners since 2004. This effort will continue and some initial results identifying those benefits should be available in 2010. The results will include lands managed using Department programs plus those managed by private and public ownerships at the landowners' own initiative.

7. Greenhouse Gas Emission Reductions

<u>GHG Emission Reductions from Identified Approaches:</u>

Here is a discussion of the methods used to quantify the expected greenhouse gas (GHG) emission reduction from the measures submitted in the 2007 macro-economic analysis and the newly added "Carbon Market – Timber Stand Improvement" measure.

Measures From 2007 Macro-Economic Analysis -

Extension of Riparian Buffers

An uptake of 1,638 acres per year (19,656 acres at year 12) entering into a riparian extension program is anticipated with an annual carbon benefit of ~3.6 tons of carbon benefit per year. The annual carbon benefit on this area is estimated to be equal to 261,630 tons of carbon dioxide per year (71,289 tons of carbon) [personal contact with Winrock International].

Results of Past Actions

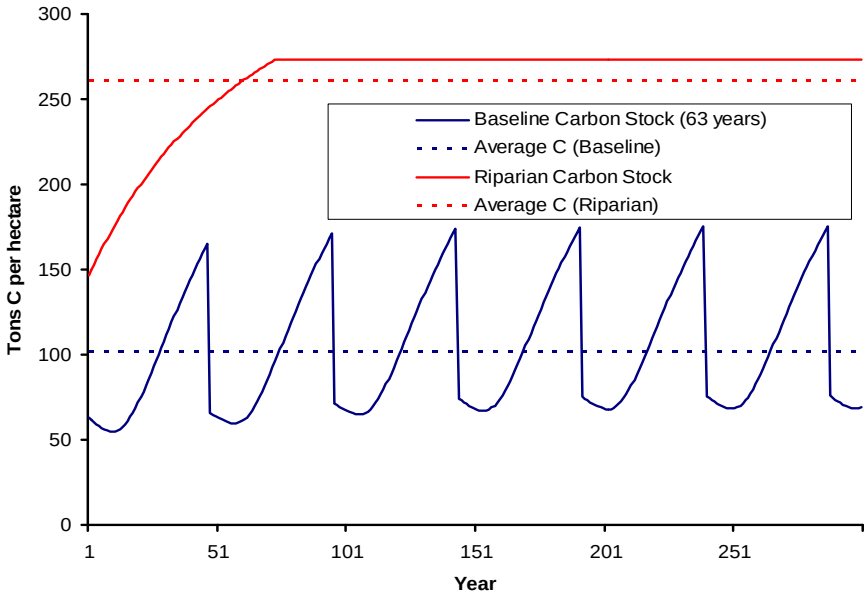
The carbon benefit of changes in the California Forest Practice Rules since December 2004 was calculated as equal to 33.55 million tons of carbon dioxide (2.4 million tons per year until 2020) [Personal contact with Winrock International]. The Forest Practice Rule changes for Threatened and Endangered Species significantly increase the riparian buffer zones for those areas with salmonids in the watercourse systems. For the purposes of this report this cumulative value is annualized and reported as 2.2 mmt/yr of carbon dioxide stored for each of the 15 years considered. This is not an annual benefit but a one-time benefit brought about by the 5% increase in commercial volume on commercial timberlands. The Forest Practice Rules are constantly being reviewed and other modifications of regulations are under consideration that will result in other management practices providing higher carbon storage. An example is rules currently under discussion by the Board of Forestry and Fire Protection and the Fish and Game Commission for the protection of salmonid populations at risk.

Methodology:

Riparian Buffer:

The carbon and cost estimates presented here are based on the Winrock International carbon supply report (Brown et al. 2004a). For forestlands, estimates of the potential carbon benefits were analyzed for permanent contracts for increasing the riparian buffer zone by an additional 200 feet (100 feet on either side of the current regulatory standard)

For the extension of riparian buffers the only forests deemed eligible were those at about harvest age (Brown et al 2004a). The baseline was a continued harvest cycle together with accrual of wood products (Brown et.al.; Baseline Development and Estimation of Carbon Benefits For Extending Forested Riparian Buffer Zones in Two Regions in California, March 2004, CEC-500-04-071F). The difference between the two alternatives is first estimated to derive annual stock differences, and then the annual change in the difference in stock is used to estimate the carbon gain for the riparian zone.



For this form of activity the land would have to be placed under an easement and the benefit would be assumed permanent. Easements typically are designed to limit development rights but do continue to allow forest management activities such as intermittent harvesting.

No carbon was available at the cost of $9.71/ton (the estimated initial PG&E price offering).

If a carbon market develops at the higher price point of $19.67/ton (2008 Vintage European Trading Scheme in October 2006) there is an estimated available area for riparian extension of 19,653 acres. Here it is assumed that over period 2008-2020 (12 years), all potential private land could be placed under this management regime if available carbon price, government funding or tax benefit is equal to $19.67/ tCO_2. At this price, the average net revenue (revenue minus cost) would be about $1,000/acre. In the analyses included here, 1/12 of the area is put under extension contracts per year between 2008 and 2020.

Wood products are included in the riparian benefit analysis above; however, the wood products are more important in the baseline than in the with-activity scenario and consequently reduce the net benefit rather than increasing it. No cost is assigned to the wood products in this analysis.

Results of Past Regulatory Actions:

Changes in the Forest Practices Rules since December 2004 have resulted in an increase in carbon stocks in California's commercial forests. New rules were added for 'Threatened and Impaired Watersheds', and a variable retention silvicultural rule was included that requires retention of large trees or groups of trees. The result of these rules would be increased watercourse strips (up to 150' for class I) and the retention of larger trees for stream and wildlife protection. The resulting response to these rules has been retention of approximately 5% more volume on average over the permitted harvest acres than in the baseline case.

This impact was evaluated using the Forest Inventory and Analysis (FIA) dataset of the US Forest Service for California in 2004. The area of private timberlands and volume of private timberlands were assessed from the FIA dataset for commercial timber species. Volume was converted to biomass using the equations of Smith et al. (2003). The benefit included here was

calculated as the difference between 2004 timberland biomass stocks and timberland biomass stocks with a 5% volume augmentation.

Uncertainty is undoubtedly large when scenarios include consideration of carbon markets that are as yet unformed. This uncertainty alone could be as high as 50 %. However, beyond this, previous studies (Brown et al. 2004c) illustrate the range of uncertainties in some of the input data used to calculate potential carbon benefits.

Identification of eligible areas:	
Federal and State Databases:	18%
Satellite Imagery:	10%
Carbon stocks:	18%
Linking carbon stocks to model:	16%
Harvest Assumptions:	8%

Using standard error propagation methods, the total uncertainty is estimated to be about 32% for all activities. When the uncertainty in area uptake is incorporated it is likely that total uncertainty will exceed 50%. Clearly this is an area in which more research could increase the certainty of the projected carbon sequestration.

New Measure Added for 2008 Economic Analysis -

Carbon Market – Timber Stand Improvement:

We estimate that level at 40,000 acres of new projects a year from 2010 forward to at least 2020 and likely to 2050. With that in mind we expect an accumulation of 220,193 tCO_2/year at 2020; 869,381 tCO_2/year at 2030; and at 2050 1.12 mm tCO_2/year. As timber stands age further out into the future the rate of gain for additional carbon shrinks until any new additional carbon is offset by tree mortality and natural decay rates. So at some point after 2050 when the level of landowner participation has reached its maximum there will be a natural cap on new carbon stored.

Methodology:
Projections of carbon and board feet were produced using the Landscape Management System (LMS ver. 2.0.46) software running the Forest Vegetation Simulator (1999). Low and high starting conditions of mixed conifer stocking were simulated. An “option C” baseline that mimicked the minimum stocking standards in the forest practice rules was modeled as was a “2005” starting point baseline that simulated cutting all growth over time to keep a constant inventory level. Projected management used the goal of harvesting 50% of growth on 15-year cutting cycles. Additionality was the marginal increase in the difference between the projected management and the baseline. Simulations were performed for each of the five primary site classes and a weighted average based on the relative frequency of occurrence of each site class was calculated for prices and carbon yields. A holdback of 20% of additionality for 20 years was simulated to mimic observed practice.

The economic analysis used the outputs from the above simulations to calculate a price per metric ton of CO_2. A discount rate of 4% and cost of $30 an acre for inventory and carbon market participation was assumed. Timber prices were taken from the latest Board of Equalization schedules ($235 per MBF for stumpage) and were kept constant. It was assumed that 30% of the market would be based on the “option C” baseline and 70% on the “2005” baseline. The price of carbon was based on above and below ground carbon pools in the forest

and long-term product storage. Yield Streams of carbon were based on the full life-cycle as estimated in LMS, which was based on the CORRIM project (2004).

8. Costs and Cost Savings

Riparian Buffer Extension:

The riparian extension areas would, under current protocols, have to be placed under a permanent easement. Conservation easements vary on a case by case basis but in general they restrict development rights but allow for some agreed upon level of forest management to continue which can include harvesting. In this paper, easement establishment does not consider a continuation of harvesting and the costs are therefore the opportunity cost of lost timber harvest within the extension zones. This cost is estimated to be a one time cost of $3.3M for the 1,638 acres placed under easement each year of the analysis. At the given carbon price of $19.67/ton this would give an average net revenue per acre of placing the land under easement of $1,010.

As the Forest Protocol development moves forward consideration is being given to establishing mechanisms other that conservation easements that address the question of permanence for carbon stock additionality.

As the carbon benefit of *approach Past Regulatory Action* is the result of past changes in the forestry law, there are no present costs for the accrued carbon.

Methodology:

For estimating the costs of enhanced riparian zone management, estimates are based on specific counties for public and private landowners, and then extrapolated to all counties throughout the state (see Brown et al. 2004a).

As the carbon benefit of approach 7 is the result of past changes in the forestry law, there are no present costs for the accrued carbon.

Uncertainty is undoubtedly large when scenarios include consideration of carbon markets that are as yet unformed and the uptake of tax incentives that are not yet legislated. This uncertainty alone could be as high as 50 %.

However, beyond this, the range of approximate uncertainties in some of the input data used to calculate potential carbon benefits is illustrated below:

Identification of eligible areas:
Federal and State Databases: 18%

Carbon stocks: 18%
Linking carbon stocks to model: 16%

Harvest Assumptions: 8%
Economic and tax data on harvests 5%

Using standard error propagation methods, the total uncertainty is estimated to be about 32% for all activities. When the uncertainty in area uptake is incorporated it is likely that total

uncertainty will exceed 50%. Clearly this is an area in which more research could increase the certainty of the projected carbon sequestration.

Carbon Market – Timber Stand Improvement:

Costs were assumed to include a one-time $30 per acre for inventory, preparation and verification cost to participate in the carbon market. This could be reduced based on specific circumstances such as having an existing inventory and management plan. Also, economies of scale will affect cost. Annual costs of forest management and carbon market participation were assumed at a constant price of $7.00 acre. Forgone timber revenue was discounted and the price of carbon adjusted so that it made up the difference with a 4% real return. The price per ton of CO2 averaged $8.81 with a range from $2 to $17 depending on site class and initial stocking.

Summary Table: GHG Emissions reductions (MMT CO2E)

MEASURE	2020 Annual	2020 Cumulative	2030 Annual	2030 Cumulative	2050 Annual	2050 Cumulative
Past Regulatory Actions	2.2	33.6				
Riparian Extension – Carbon Market	0.26	3.4				
Timber Stand Improvement - Carbon Market	0.22	1.3	0.89	6.4	1.12	--

9. Other Benefits

It is not anticipated that the forest management strategy will lead to reductions in emissions of pollutants such as VOCs, NOx, SOx and PM. However, the other benefits associated with the strategy are significant.

Preservation and enlargement of riparian buffers will lead to benefits to biodiversity and wildlife as habitats are less severely disturbed and will mature, enhancing their habitat value. The enlarged buffers will also benefit water supply with less runoff and erosion occurring on streams and rivers with a lower harvesting regime and the water temperature could be lower, enhancing habitat for aquatic organisms. This will also benefit the aesthetic value of the sites for all Californians.

The Timber Stand Improvement projects will provide these same benefits and increase the overall forest health. Improved forest health results in a reduction in mortality and a reduced risk of extreme wildfire events. The reduced risk of wildfire provides the additional benefit of reduced erosion following the fire. The reduced erosion is a direct benefit to the maintenance of downstream water storage structures and reduced riparian and watercourse damage.

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Climate Action Team
Forestry Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

The purpose of this document is to provide the public with information about options considered and analyzed by the Climate Action Team (CAT) Sector Sub Groups for Air Board's consideration and potential inclusion in the Scoping Plan. This information should be drawn from the Measure Analyses previously developed by each Sub Group.

Information should only be updated to reflect significant changes in technology, staff assignments, and understanding of the issues.

Outline

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Climate Action Team
Forestry Sector Sub Group

Scoping Plan Measure Development and Cost Analysis

The purpose of this document is to provide the public with information about options considered and analyzed by the Climate Action Team (CAT) Sector Sub Groups for Air Board's consideration and potential inclusion in the Scoping Plan. This information should be drawn from the Measure Analyses previously developed by each Sub Group.

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1. Measure: Forest Conservation

2. Agency: California Department of Forestry and Fire Protection.

3. Measure Description

Overview

California forests and woodlands continue to be developed and converted to non-forest uses. These conversions result in both the immediate release of CO_2 through vegetation removal and the reduced opportunity to sequester additional carbon in the future on woodlands and forestlands that are currently young and/or not fully stocked.

CAL FIRE's Fire and Resources Assessment Program (FRAP) found that between 1989 and 2000, almost 70,000 acres on average experienced some development to residential or industrial use per year (Stewart, 2006). The majority of development (>40,000 acres) was very scattered, however, about 28,000 acres were "parcelized" (i.e., had at least one house per 20 acres built). About 18,000 acres of the parcelized acreage was forest land, which is similar to CAL FIRE's Timberland Conversion data showing 16,000 timberland acres converted per year from 1998 to 2004 (excluding conversions conducted under 3 acre exemptions), though higher than the US Forest Service Inventory Analysis (FIA) estimate of 7,600 acres per year from 1984 to 1994.

FRAP (2003) projections for 2000 to 2020 estimate an annual conversion of 570,000 total for 20 years, and an average of 28,500 total ac per year (15,600 forest and 12,900 ac woodlands). Breakdown by vegetation types are in Table 1.

Table 1. Projected forest and woodland conversions from 2000-2020 by vegetation type.

Major Vegetation Type	Total Acres	Percent Acres
Forest	15,600	55%
Woodland	12,900	45%

Forest and woodlands may also be converted for agriculture. More than 2,000 acres were converted to vineyards in Sonoma, Mendocino and Lake Counties over the last 10 years (Giusti, 2006). CAL FIRE's timberland conversion database shows that 1,317 forestland acres were converted to vineyards annually between 1998 and 2004, though economic indicators suggest

this will decline in the future (Stewart, 2006). Other areas may be converted for rights of way. The US Forest Inventory Analysis (FIA) indicates that approximately 4,560 acres were converted for roads, powerlines, rail and pipelines annually from 1984 to 1994.

The potential exists to avoid or reduce carbon emissions by encouraging fewer conversions of forests and woodlands to other land uses. Mechanisms to reduce the rate of conversions are of interest to landowners, state and local governments, non-governmental organizations (NGOs) and others. Agencies or (NGOs) may buy or accept donations of forestland (fee title), easements or other interests to preserve them for forest uses such as habitat, recreation, community forestry and timber management. When easements or other interests are sold or donated, the landowner can have the property assessed for the purposes of lowering their tax liability. They are typically turned over to an agency or non-profit entity, which is responsible for enforcing easement conditions. To ensure carbon sequestration over the long term, these forest and woodland land purchases would generally require permanent retirement of development rights, preclude uses that would reduce carbon stocks or sequestration capacity, and include management geared toward maintaining or increasing carbon sequestration through conservation management projects.

Forest land conservation projects will be designed to avoid emissions caused by forest and woodland conversion and to sequester additional CO2 by increasing forest carbon stocks , through conservation and or forest management on these lands. CAL FIRE will work with state and local agencies, private landowners and NGOs to identify lands with high carbon stock values, to evaluate opportunities to increase growth and sequestration, and to implement practices to protect and enhance those carbon stocks.

Affected Entities

- Private landowners with conifer forestland, montane and oak woodlands, and riparian woodlands may sell or donate easements to preserve forests and protect or increase carbon. These may include industrial and non-industrial timberland owners, smaller landowners with forested and woodland parcels, ranchers and land trusts.
- Non-governmental organizations, such as national, state and local land trusts, may purchase, broker and/or hold forest lands, easements or other interests. CAL FIRE identified 132 land trusts in California (FRAP 2003).
- State agencies may acquire and manage properties for conservation purposes, including forested and woodland parcels. Land holding agencies include CAL FIRE, Department of Fish and Game (DFG), Department of Parks and Recreation (DPR), State Lands Commission, and various conservancies. Other agencies, such as the State Coastal Conservancy (SCC), Sierra Nevada Conservancy, Tahoe Conservancy, Wildlife Conservation Board and DPR provide funding for acquisitions or easements by state and local agencies or non-profit trusts.
- Local government: Local agencies may contribute to or increase forest conservation through direct purchases and ownership of forested tracts, by incorporating GHG considerations into land use planning and development project review processes, and by participating in carbon marketing in the future.
- Federal agencies: Federal land owners, such as the US Forest Service (USFS), USDI National Park Service (NPS) and USDI Bureau of Land Management (BLM), may increase conservation acreage by providing additional funding for state assistance programs and incorporating carbon sequestration criteria into these programs. They can also participate by recording carbon on federally reserved lands.

Environmental Justice, Small Business, Public Health, Leakage and CEQA

AB 32 (The Global Warming Solutions Act) carried Environmental Justice forward as an interest to be addressed in each of the major emission sectors. It established an Environmental Justice Advisory Committee (EJAC) which has held d numerous meetings that have been advertised on the ARB website. Forestry Sector concerns were discussed in these meetings.

A set of public meetings addressing the Forest Sector were held November 2007 - February 2008 for the AB 32 Scoping Plan. These meetings were also advertised on the ARB website to invite public participation. No Environmental Justice Issues were raised during those meeting. EJAC raised one specific comment in recommendations on ARB Early Actions. Other possible concerns for the Forestry Sector are also listed below. Topics which need consideration for the Forest Sector are:

- The Committee has deep concern about the appropriate use of forest-based carbon sequestration and its potential as a long term solution for meeting California's GHG reduction targets.
- The use of chemicals in forest management activities.
- The use of offsets to permit continued pollution by regulated sectors.
- In Urban areas tree plantings should be appropriately distributed to all communities.
- Fire Suppression efforts should be equal amongst all communities threatened by large damaging wildfires.

The concern that the use of offsets (including forest offsets) will permit continued pollution by regulated sectors is not completely addressed. This issue is still under discussion by the participants in this and other processes. One possible outcome would be some restriction on what the offsets could be used for. Example, if forest sequestration offsets were only allowed to offset Carbon Dioxide, then the criteria pollutants and other harmful substances would have to be dealt with through other mechanisms such as reductions through technology.

In the development of Forestry Sector measures for the AB 32 Scoping Plan, ARB held two stakeholder workshops in Sacramento to obtain input and suggestions and solicited input via the web. CAL FIRE also notified a stakeholder list used in developing urban forestry protocols.

Forestland conservation (avoiding conversion) endeavors to retain forest cover at risk of development, and is thus focused on developing or interface areas rather than highly urbanized ones. Nothing in this measure interferes with public health efforts such as achieving and maintaining federal and State air quality standards and reducing toxic emissions. To the extent that conservation helps reduce sprawl, it will reduce pollutants associated with vehicle miles. Activities of the Environmental Justice Advisory Committee were not directly considered in the development of this emission reduction measure.

No significant potential effects on small business are expected from the implementation of theses measures. Voluntary land transactions of fee title or easements take place between the State and landowners. Conservation of lands for open space or other uses may reduce availability for other economic uses, however the State has declared in the California Forest Practice Act the public interest in maintaining forestland for multiple uses and benefits.

No emissions are anticipated to be associated with this measure.

Finally, regarding leakage, conceptually it is the storage of carbon with one forest activity while a separate activity removes other forest carbon, thus reducing the atmospheric benefit of the

original project. Carbon sequestration is subject to two types of leakage. The two types of leakage that may occur with forest projects are “activity shifting” and “market”.

There is some potential for leakage from these measures, since demand for development may be pushed to other forest or woodland areas. Activity shifting leakage is dealt with in the Forest Carbon Accounting Protocols adopted by the California Climate Action Registry (CCAR) and the Air Resources Board. Where this type of leakage may occur deductions are charged against the possible amount of carbon storage that may be certified by CCAR. Market leakage is a much more difficult area to address and work on solutions are continuing during the current CCAR review and updating of the Forest Protocols.

Leakage for this measure could be minimized by maintaining working forest, forested landscapes, strengthening state and local policies, statutes and ordinances to minimize development footprints, encourage denser developments, and direct development away from productive forests or woodlands.

These measures provide additional benefits such as visual amenities, open space and recreational opportunities, and watershed protection.

Related Objectives

The Measure is Motivated by Multiple Benefits: Forestland conservation provides multiple climate change benefits as well as additional environmental and economic benefits associated with protecting wildlife and habitats, recreational opportunities, watersheds and working landscapes. Forest conservation ensures that land is available for continued or enhanced sequestration of carbon in trees. Preserving abundant forest cover also buffers landscapes from other climate change impacts such as changes in hydrology, evapotranspiration and watershed processes, increased temperatures and associated impacts to wildlife. Conserving large tracts of land in forest cover also protects wildlife and reduces habitat fragmentation, and provides opportunities for recreation, wood product production and use for other forest products.

Measure Metrics

The metrics for conservation projects are acres of conserved forest and woodlands and avoided emissions derived from conserving those lands.

Measure Goals and Implementation Approaches

The strategy goal is to reduce greenhouse gas emissions that result from forest and woodland land use conversions. Conversions remove trees and replace them with non-vegetative cover or vegetation that is less effective at carbon sequestration.

The following implementation approaches have already been funded or have a high likelihood of funding available to them:

1. Proposition 40 and 50 purchases of forest and woodland in 2005 and 2006.

This implementation approach protected forests and woodlands from conversion through fee title or easements. Acquisitions after December 2004 were counted toward this goal.

2. Prop 84 purchases to conserve forest and oak woodland habitats.

Prop 84 was passed by voters in November 2006. Chapter 6 provides the Wildlife Conservation Board (WCB) $180 million for forest protection and conservation projects (75055a) and an additional $15 million for oak woodland preservation. CAL FIRE will work with WCB and others to incorporate GHG emissions and carbon sequestration goals and criteria into the forest habitat protection grant program which begins in 2007. SB 1686, chaptered in September 2006, authorizes WCB to consider a project's potential to reduce or sequester greenhouse gas emissions when prioritizing proposed forestland acquisitions. WCB could use policies, protocols, or other relevant information developed by the California Climate Action Registry and others for this purpose.

The Resources Agency provides leadership for getting other departments, such as WCB, DFG, DPR, State Coastal Conservancy (SCC) and State Lands Commission (SLC), more involved in climate action. CAL FIRE will assist them, as resources are available, with evaluating carbon sequestration stocks and identifying contributions by other grant programs. The oak woodland conservation program, which includes restoration and regeneration as goals, provides good opportunities to enhance carbon.

3. Future Funding.

This implementation assumes that California's are likely to adopted future measures that will contain funds to purchase additional conservation easements on forest and woodlands. The analysis presented here assumes funding for forest and woodland conservation projects that is comparable to Prop 84 (described above).

Mitigation for conversions.

This measure proposes that CAL FIRE and local land use agencies require mitigation of conversions. CAL FIRE can require compensatory mitigation (1 to 2 acres for every acre converted) of timberland conversions when under CEQA a finding of significance is supported for that loss of the forestland. It also assumes that local land use entities will require, on the average, 1:1 mitigation.

Mitigations could occur either through land conservation or reforestation. Reforestation allows more flexibility, is less costly and probably more politically feasible. Both reforestation and forestland conservation mitigation were analyzed. Conservation produced slightly less GHG benefit. For these reasons, mitigation for conversion is addressed under reforestation and no forestland conservation measure is included in this strategy.

Other Actions Suggested by Stakeholders

Two stakeholders meetings were held in February to request submission of recommended measures to meet the AB 32 GHG emission reduction targets for 2020. Additional measures were suggested that could assist in enhancing GHG benefits, however the Department of Forestry and Fire Protection cannot analyze or recommend these at this time.

- Landowner consortium – Multiple landowners may combine contiguous properties to optimize easements and fee title sales and lands or donate easements as a group for habitat, open space or conservation purposes. A third party, such as a regional conservation district or non-governmental organization (NGO) may broker these types of arrangements.
- Land Use Planning – Local land use planning tools could be used to reduce forestland conversion. They can encourage denser development, require or provide incentives for

mitigation of conversions, or purchase forests and woodland fee titles or easements for open space, habitat lands, watershed protection or other compatible uses. Tools include General Plan policies and elements (e.g. conservation, open space, housing elements and optional elements addressing watershed resources, etc.), ordinances, mitigation banking, development density incentives, and other tools.

- NGO and local government programs – NGOs can work with local agencies to broker, fund or hold easements for conserved lands, accept and retire development rights, and assist with management and monitoring.
- Public/Private Partnerships – Landowners, NGOs and other private entities often work with agencies to buy and sell conservation lands and easements. These partnerships help leverage funding from any one source. Agencies and NGOs can hold easements or title for permanent protection of these lands.
- A measure was proposed to amend the Timberland Production Zone (TPZ) tax law to reduce the total tax burden for timberland owners, thus providing an incentive to defer decisions to withdraw their ownership from TPZ and convert it to non-timber growing uses (deforestation). The Department was not able to determine a quantitative means of estimating these benefits.
- Continue to work for changes in federal Forest Legacy Program – The state Forest Legacy Program differs from the federal program in that it allows purchased easements to be held by non-government trusts. While there is more opportunity to achieve conservation acreage through easements than through fee title, many landowners did not want to sell or donate easements to government agencies. Therefore, CAL FIRE and others will work with federal agencies to change federal program requirements related to eligible easement holders.
- Carbon Markets – This effort assumes that the outcome of the Scoping Plan effort will be the establishment of a cap and trade program that permits the use of forest-based offsets. Assuming that a carbon offset market will be established, it will need to be functional by the date the caps are mandated to begin in 2011. It should be noted here that the more quickly some certainty can be provided to persons who wish to invest in a carbon offset market; the more quickly landowners will begin reforestation and afforestation projects.
- A public goods charge on wood products and paper products was proposed to fund various forestry mitigation actions. It would direct $75 million per year to forestland conservation.

Additional suggestions included:

- Working Forest easements
- Third party review of projects
- Tracking and documentation
- Communication/education/outreach
- Improved communication between state and county.

4. Technology

No new technologies are associated with this strategy.

5. Statutory Status

The following areas will or may need state legislative action:

Continue to work for changes in federal Forest Legacy Program

CAL FIRE worked with federal agencies in 2007 to pursue changes to the federal program to allow non-profits to hold easements. Given the relatively small amount of funding compared to state sources, progress on this is not critical to achieving goals under the current timeline.

Consider CEQA amendments to ensure achievement of GHG emissions reductions goals.

SB 1334 (Kuehl, 2004) increased requirements for mitigating oak woodlands affected by development proposals. Additional CEQA amendments have been discussed to require consideration of GHG emissions and carbon sequestration. Non-legislative approaches include amending CEQA guidelines. CAL FIRE will work with other agencies and with the CAT to consider whether amendments to CEQA are needed or appropriate to reducing GHG emissions and increasing carbon stocks and sequestration.

6. Implementation Steps and Timeline

Each of the implementation approaches listed above is addressed individually below.

1. State purchases of forest and woodland fee title and easements from 2005 to 2006.

A conservative estimate of 2005-2006 purchases toward this goal was made by querying the Resources Agency's Prop 40/50 Awards database to identify conifer and hardwood habitats bought in title or easements since 12/31/04.

a. After adding a number of forest habitat projects to this list, we identified approximately 46,000 acres of forest conservation purchases and about 38,000 acres of woodland purchases. This estimate is conservative, since many database entries did not include information about vegetation type. These purchases were split evenly between two years, so that we assume that 23,000 acres of forest land was conserved per year in 2005 and 2006, and that 19,000 acres of oak woodlands were conserved each year in 2005 and 2006. In total, about 84,000 acres were conserved at a cost of almost $54 million.

b. The initial estimate will be refined by working with WCB, DPR, SCC and conservancies to reconcile and improve databases w/re to acreage and vegetation type. This will allow us to improve our ability to estimate contributions to carbon sequestration.

2. Conservation purchases of easements and fee title, starting in 2007.

The forest habitat and oak woodland programs identified in Proposition 84, passed in November 2006, provide major opportunities for additional forest and woodland purchases that can improve carbon sequestration and thus assist the state in its GHG reduction strategy. It provides $180 million for forests and $15 million for oak woodlands. Subtracting 5% overhead for program administration leaves $171 million and $14 million, respectively.

The price of forest and woodland property or easements varies widely, depending on proximity to urban areas, parcel size, tree stocking, etc. The average cost to the State for the 84,000 acres identified in the Prop 40/50 database (supplemented with additional WCB information) was less than $650 per acre. The average cost of 6,200 acres of forest land conserved under CAL FIRE's Forest Legacy Program during 2005 and 2006 was approximately $1,400 per acre.

a. WCB developed program guidelines in summer 2007 and will begin to provide funding for conservation purchases in 2008. CAL FIRE will provide staff to assist WCB in considering the incorporation of carbon criteria into the program guidelines, as authorized by SB 1686.

b. Based on input from WCB, we assumed that $35 million will be spent annually, starting in 2008.

c. We assumed an average purchase cost of $1,400 per acre, based on the discussion above, which we divided into the projected annual funding to give the acreage listed in Table 1.

d. Two CAL FIRE staff are available to assist WCB, as needed, in developing these projects.

7. Greenhouse Gas Emission Reductions

The emission reduction benefit of forest and woodland conservation is driven by the area of land protected and the carbon stored per acre. This includes the avoidance of the immediate emission of CO2 that would occur if the land were converted to another use that results in the reduction or removal of tree biomass. It also includes the loss of additional carbon that the land would have sequestered over time, since USFS inventory and CAL FIRE analysis indicate that California's forests are currently increasing in volume per year (FRAP, 2003).

7.1 Avoided Conversion

California has almost 25 million acres of conifer and hardwood forest lands and about 7.5 million acres of hardwood and conifer woodlands (FRAP, 2003). The statistical probability that a random acre of these wildlands will be developed is very low. Conservation programs, however, typically target lands that are at some risk of development or land use change due to stated landowner objectives, encroaching development, changes in surrounding land uses or in local infrastructure supporting current land use, or other factors.

CAL FIRE analyzed the development of 28,000 acres of forests and woodlands with sparse or scattered structures that underwent parcelization (construction of at least one house per 20 acres). Table 4 shows that annually approximately 80% went into 5-20 ac parcels, 15-20% to parcels larger than 0.5 ac but less than 5 acres, and only 1-2% ended up in half acre or smaller parcels.

Table 4. Acreage and Percent of Parcelized Forest and Woodland Area in 3 Lot Sizes

	Acreage by Lot Size				**Percent Acreage by Lot Size**		
Vegetation Type	Interface 5-20 ac	Urban 0.5-5 ac	Very Urban <0.5 ac	**Total Ac**	Interface 5-20 ac	Urban 0.5-5 ac	Very Urban <0.5 ac
Forest	15,591	2,687	185	18,463	84.4%	14.6%	1.0%
Woodland	7,717	1,932	168	9,817	78.6%	19.7%	1.7%
Totals	23,308	4,619	353	28,280	na	na	na

The proportion of native biomass removal from these converted areas will vary, depending on land use, parcel size and original cover. Assumptions are listed in the next section.

Additional acreage may be converted to rights of way and vineyards. These conversions may remove more biomass per acre development than a residential footprint. The FIA indicates that 4,560 acres were converted for purpose of rights-of-way for roads, powerlines, rail and pipelines.

Vineyard development has slowed down in some counties but is increasing in others. An annual average of about 2,000 acres was converted in just Sonoma, Mendocino and Lake counties in the preceding decade (Giusti, pers comm. 2006). CDF's timberland conversion data shows that 1,317 forestland acres were converted to vineyards on an annual basis between 1998 and 2004. Vineyard conversions are more likely to occur in oak woodlands than in forestland in the near future (Stewart, pers comm. 2006). Many oak woodlands cleared for

vineyards are those with scattered tree cover, and attempts are often made to retain the trees (Giusti, pers. comm., 2006). No separate analysis for vineyards or rights of way is conducted.

Assumptions for Calculating CO_2 Emissions

To estimate expected CO_2 emissions from projected land conversion, we assumed that:

- Avoided emissions occur only at year of purchase. This is a very conservative assumption since in many counties parcels can readily be split into four lots without environmental review. Many parcels will also likely be developed into subdivisions at some point in the future. If programs can demonstrate that more intensive development would likely have occurred within the analysis period (i.e. before 2020), avoided emissions could be recalculated to demonstrate the greater GHG reduction benefits.
- Purchased conserved acreage would have been developed at current annual parcelization rates presented in Table 5.
- Biomass would have been removed from developed sites at the rates below and burned or otherwise disposed so as to decompose that year.
    - 10% biomass removal for 5-20 ac lots
    - 25% biomass removal for 0.5-5 ac lots
    - 80% biomass removal for < 0.5 ac lots
- Biomass estimates of 426 tons CO2/ac for forest and 57 tons CO2/ac for woodlands are used. These rates are derived from Waddell and Barrett (2005), Smith et. al (2004) and FRAP (2003). The forestland per acre estimate is almost twice that used in the CAT report analysis by Winrock International, while the woodland estimate is almost half (231 and 102 tons CO2/ac, respectively). Winrock estimates were derived from a combination of spatial analysis and USFS' 2005 Forest Inventory Analysis (Pearson, 2007).

Calculation Steps:

1) Calculate the amount of the purchased conserved forest and woodland acreage (Tables 2a and 2b) that would have actually been clear or converted by multiplying (Table 3) by the product of the parcelization rates (Table 4) and biomass removal rates for those parcels (listed in assumptions). These are combined in the following formulas:
    - Forest Ac ((.844 x.1)+(.146 x.25)+(.01 x.8)) = Ac (.0844+.0364+.008)= Ac (0.1288)
    - Woodland Ac ((.017 x.8)+(.197*0.25)+(.786*.1)) = Ac (.0137+.0492+.0786) = Ac (0.1415)
2) Calculate the one-time avoided emissions by calculating the CO2 value of the biomass that would have been removed from the acres of avoided conversion. This is done by multiplying the acres of actual avoided conversion (Table 5) by the average biomass per acre (i.e. 426 tons CO2/ac for forest and 57 tons CO2/ac for woodlands).

7.2 Avoided lost sequestration

In addition to the one-time avoided emission described above, it was assumed that the acres that would have been converted will continue to add biomass volume for a period of time until the stands mature. Avoided lost sequestration would occur on the area that would have been cleared if it had been developed.

Assumptions for Calculating CO_2 Emissions

- Analysis is based on cumulative acres of avoided conversion.
- Established forests sequester 4.3 tons CO2/ac/yr and woodlands sequester 0.6 tons/ac/yr. These rates are derived from Waddell and Barrett (2005), FIA data (2007) and FRAP (2003). They are almost twice as high as the estimates in the CAT report (i.e. 2.2 and .35 tons/ac), which were derived from the IPCC Good Practice Guidance (2003) and underestimate California conditions.
- Growth rates tail off after 25 years as stands mature and CO2 uptake approaches equilibrium with emissions.

Calculation Steps:

1) Add up avoided conversion acres by major vegetation type for each year.
2) Multiply that acreage by 4.3 ton carbon dioxide /ac/yr and 0.6 ton CO2/ac/yr.

Total GHG Reductions

One time avoided emissions are added to ongoing sequestration to calculate total annual GHG benefits for each year.

With existing programs (Prop40/50 and Prop 84) the majority of benefits accrue from avoided conversion at the time of purchase, limited benefits show up at 2020. Therefore we add up the cumulative benefits and divide by 16 years (the period from 2005 to 2020, inclusive) to get an annualized amount of 0.65 MMT. With the assumption of future funding the cumulative benefits are extended through 2030 (26 years) and results in an annualized amount of 1.27 MMT CO2/yr.

Uncertainty

Various areas of uncertainty are indicated in the assumptions. They include the difficulty of achieving conservation targets for specific vegetation types. Conservation purchases must often be opportunistic, and our ability to acquire precisely the type of land in the proportions desired may be limited. The cost of land used for the analysis was also on the high end of a very wide range of costs.

Uncertainties in the methodology also exist. As described above, the methodology for avoided emission is very conservative. In many counties parcels can readily be split into four lots without environmental review. Many parcels will also likely be developed into subdivisions at some point in the future. If programs can demonstrate that more intensive development would likely have occurred within the analysis period (i.e. before 2020), avoided emissions could be recalculated to demonstrate the greater GHG reduction benefits. Other land use conversions, such as agriculture and rights of way, may remove much higher amounts of biomass on large parcels than the 10% estimate for interface lands described in this analysis. Other methodological consideration include the opportunity to improve factors for biomass loads and uptake for applicability to California.

The US Forest Service – Forest Inventory and Analysis (FIA) database documentation (http://ncrs2.fs.fed.us/4801/fiadb/fiadb_documentation/fiadb_chapter2.htm) presents a general discussion of error in FIA analyses. According to this source, by Forest Service mandate, sampling error for area must not exceed 3% per 1 million acres. By this method, the estimates

of conifer forests should have an error percentage at the 95% confidence level of 2.4%; for the oak woodlands, the error would be 4.3%. For volume, error should be within 10% (for Western U.S. forests) per 1 billion cubic feet of growing stock, although these figures are not mandated. Using this error value gives errors for the biomass estimates of 2.5% for the conifers and 6.6% for the oak woodlands.

Using error propagation and weighting woodlands and conifers equally gives an estimated uncertainty of 8.6% for the carbon input data. Using FIA gives conservative numbers and it is possible that areas chosen for conservation will have higher biomass stocks than the average for the 'large size class' in the FIA database. This is also an uncertainty but it is systematic and conservative so will not be considered further here.

Uncertainty also exists in the growth rate of the trees that would have been cut down in the absence of the conservation activity. This is a small component relative to the emissions from the vegetation removal and will not alter the total uncertainty.

The uncertainty in the proportion of the biomass carbon that is removed in the process of development is highly uncertain and requires additional research. Here we estimate an uncertainty of 30%. Using propagation of errors gives a new combined error of 31%.

The additional uncertainty can not be quantified. This uncertainty is in the location and rate at which conservation activities are implemented. This will be determined by state agencies and private landowners across the State as well as Federal and International interest and pressure regarding climate change.

8. Costs and Cost Savings

The costs of implementation approach 1 is non-existent for current purposes, as projects have occurred in the past. Fifty-four million dollars were spent to conserve 84,000 acres. In implementation approach 2, total cost is assumed to be the amount of funding available. No estimates are included here for the impact of a carbon market on uptake of conservation activities in California. On purely economic grounds no carbon market can compete with development if a real threat exists for the site to be rezoned and cleared of vegetation; the opportunity cost of not developing the land would be prohibitive. Where the income from development is least is in the areas of sparse development where few trees would be cut and hence carbon credits will also be lowest (e.g. 10% or less of standing carbon stock).

The carbon market will therefore have an impact only for those whose motivation is not purely financial but for whom the small income from carbon is enough to reinforce alternative motivations for maintaining undeveloped land. It is not possible, without significant additional research, to identify if there will be such an impact and on what scale it would occur.

The cost of conservation for forestry with new funding is estimated to be comparable to the costs for implementing Prop 84. Prop 84 provides the Wildlife Conservation Board (WCB) $180 million for forest protection and conservation projects (75055a) and an additional $15 million for oak woodland preservation.

9. Other Benefits

Forestland conservation provides multiple climate change benefits as well as additional environmental and economic benefits associated with protecting wildlife and habitats, recreational opportunities, watersheds and working landscapes. In contrast to the other forest sector strategies such as reforestation, the climate benefits of forest conservation are immediate. Forest conservation ensures that land is available for continued or enhanced

sequestration of carbon in trees. Preserving abundant forest cover also buffers landscapes from other climate change impacts such as changes in hydrology, evapotranspiration and watershed processes, increased temperatures and associated impacts to wildlife. Conserving large tracts of land in forest cover also protects wildlife and reduces habitat fragmentation, and provides opportunities for recreation, wood product production and use for other forest products.

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Climate Action Team
Forestry Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

The purpose of this document is to provide the public with information about options considered and analyzed by the Climate Action Team (CAT) Sector Sub Groups for Air Board's consideration and potential inclusion in the Scoping Plan. This information should be drawn from the Measure Analyses previously developed by each Sub Group.

Information should only be updated to reflect significant changes in technology, staff assignments, and understanding of the issues.

Outline

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Climate Action Team

Forestry Sub Group

Scoping Plan Measure Development and Cost Analysis

The purpose of this document is to provide the public with information about options considered and analyzed by the Climate Action Team (CAT) Sector Sub Groups for Air Board's consideration and potential inclusion in the Scoping Plan. This information should be drawn from the Measure Analyses previously developed by each Sub Group.

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1. Measure: Fuels Management

2. Agency: Department of Forestry and Fire Protection

3. Measure Description

Overview

This Fuels Management/Biomass measure is designed to reduce greenhouse gas (GHG) emissions through the use of timely fuel hazard reduction treatments on suitable forest land throughout the state. While hazardous fuel reduction techniques include fire use, biological methods, and mechanical treatments, this measure focuses solely on mechanical treatments as a means of reducing fire hazard.[1] This measure combines the fire prevention benefits of fuel hazard reduction with the supply of biomass for use in bio-power and bio-fuel production. Therefore, this measure supports the goals of the Bioenergy Action Plan, including the goal to enhance the supply of biomass through fuel hazard reduction (CEC, 2006).

This measure reduces GHG emissions through two primary mechanisms:

1. Through hazardous fuel treatment, the frequency and severity of wildfires will be reduced. As a result, CO_2 emissions will be reduced and more carbon will remain in forest biomass.
2. The fuel (biomass) removed as part of the treatment can be used to produce electricity and liquid fuels. This biomass-based energy can displace the use of fossil energy (natural gas for electricity production and petroleum-based gasoline), thereby displacing the GHG emissions from the use of these fossil fuels.

This measure is constructed in two parts. The first part focuses on the fuels treatments that can be accomplished through state funding and coordination with federal forest management activities. This element of the measure is limited primarily by the funds available to support treatment activities.

The second element is focused on producing biomass to support the goals of the Bioenergy Action Plan. The forest lands requiring treatment are significantly larger than the areas that can be addressed with available funding in the first part of the measure. By promoting the use of

[1] Mechanical fuel treatment can include crushing brush and other fuels as well as removing trees that serve as ladder fuels to the crown.

biomass for bio-power (electricity) and bio-fuel production, the measure proposes to achieve forest management goals by satisfying the growing demand for renewable energy sources.

It is commonly accepted that the reduction total forest fuel load along with changing the structure and arrangement of those fuels has a positive effect on the ability of fire suppression forces to control a fire. Those benefits occur both when a fire is small, thus increasing the success rate of initial attack forces; and once a fire becomes large by providing a fuel bed that encourages crown fires to fall to the ground where suppression forces can gain the upper hand. This measure is constructed using very conservative assumptions so as not to overestimate the potential climate value of acres treated for fuel hazard reduction to reduce the potential for large damaging fires. This Measure is the least developed of the five forest strategies presented due to research needs. Given short time frames, it has not been possible to review or update the measure; the intent is to do so in the coming months.

Though the benefits are recognizable, the ability to quantify those benefits has yet to be fully developed. The Department in cooperation with numerous other federal and state agencies have undertaken research projects to not only identify how fuels treatment modifies real time fire behavior, but reduces the risk of fire starts becoming large damaging events. Two significant studies have been initiated to help answer questions surrounding risk assessment and wildfire. The first is under the Western Carbon Sequestration Partnership (Department of Energy) and a separate partnership of the US Forest Service, California Energy Commission, and Department of Forestry and Fire Protection have initiated a similar study on the Mendocino National Forest. Both studies generally try to identify the risk of a fire starting in an area and then the risk of the fire becoming large given the fuel conditions at and surrounding the point of ignition. This is filling research gaps that have existed for at least a decade. These research projects have been underway for over a year and preliminary results are expected within the next year. Until we have those results that will allow us to provide more accurate estimates we have developed the proxy analytical process used in this document.

Affected Entities

The affected entities for Fuel Management/Biomass include but are not limited to:

- Private Landowners: This measure will apply to conifer, montane hardwood, oak woodland, grasslands and chaparral covered lands that are privately owned. The measure envisions promoting fuel hazard treatment by these landowners.
- Public Landowners: The measure proposes to maintain and enhance the level of fuel hazard reduction activities by Federal and state landowners. State funding for fuel hazard treatment on state-owned lands is required to implement this element of the measure.
- Regulatory Agencies: Treatment in the conifer forest vegetation types will likely involve removing some trees with commercial value. Sale of these trees will help pay for the fuel hazard reduction treatment, but could also trigger review and involvement by regulatory agencies. Agencies involved with forest management on private lands include the State and Regional Water Resources Control Boards, Department of Fish and Game, California Geological Survey, Air Resources Board, Coastal Commission, Native American Heritage Commission, county governments, National Marine Fisheries Service, US Fish and Wildlife Service, and US Environmental Protection Agency. Each of these agencies has regulatory authority over a particular resource that may be impacted by forest management activities.

- Nonprofits: California has numerous nonprofit organizations that are involved with management of the state's resources. Examples of these organizations are The Nature Conservancy, Conservation Fund, Pacific Forest Trust, local land trusts, Sierra Club, Fire Safe Councils, and a variety of organizations representing forest professionals. These entities also have a variety of objectives and missions that impact land use allocations or groups of projects with possible environmental impacts, and it is anticipated that this measure will attract the involvement of some of these groups and other groups.
- Local Government: Counties and cities periodically revise their General Plans to account for fire safety in their land use actions. This measure will be supported through the submission by counties of amendments to the public safety element of their General Plans to the Board of Forestry and Fire Protection as required by the Government Code.
- Bioenergy Producers: A critical aspect of this measure is the production of bioenergy from the biomass removed from forest lands. The capacity to utilize this biomass to produce electricity and liquid fuels must be expanded considerably in order to achieve the goals of the Bioenergy Action Plan and this measure. The Governor's Executive Order S-6-06 sets targets for increased use of renewable energy in the Renewable Portfolio Standard (RPS)..By 2020 all energy in California is supposed to be 20% renewable energy with 20% of the electric power being produced using biomass fuel.

Environmental Justice, Small Business, Public Health, Leakage and CEQA

Environmental Justice has been considered from the beginning of the public deliberations on Climate Change by both the California Climate Action Team and the Air Resources Board (ARB). Subsequent to the issuance of the 2006 Climate Action Team Report the State Legislature passed AB 32 (The Global Warming Solutions Act) and the Governor signed the bill. AB 32 became effective January 1, 2007. The bill carried Environmental Justice forward as an interest to be addressed in each of the major emission sectors. Forestry is one of those sectors. ARB established an Environmental Justice Advisory Committee (EJAC) as required by AB 32. This committee has had numerous meetings that have been advertised on the ARB website. Forestry Sector concerns were discussed in these meetings.

A set of public meetings addressing the Forest Sector were held in February 2008 for the AB 32 Scoping Plan. These meetings were also advertised on the Website to invite public participation. No Environmental Justice Issues were raised during those meeting.

EJAC raised one specific comment in recommendations on ARB Early Actions. Other possible concerns for the Forestry Sector are also listed below. Topics which need consideration for the Forest Sector are:

- The Committee has deep concern about the appropriate use of forest-based carbon sequestration and its potential as a long term solution for meeting California's GHG reduction targets.
- The use of chemicals in forest management activities.
- The use of offsets to permit continued pollution by regulated sectors.
- In Urban areas tree plantings should be appropriately distributed to all communities.
- Fire Suppression efforts should be equal amongst all communities threatened by large damaging wildfires.

The concern that the use of offsets (including forest offsets) will permit continued pollution by regulated sectors is not completely addressed. This issue is still under discussion by the

participants in this and other processes. One possible outcome would be some restriction on what the offsets could be used for. Example, if forest sequestration offsets were only allowed to offset Carbon Dioxide, then the criteria pollutants and other harmful substances would have to be dealt with through other mechanisms such as reductions through technology.

There is some concern that tree planting under the California Department of Forestry and Fire Protections (Department) Urban Forestry program may not be evenly applied to all communities. This is addressed in guidelines used by the Department for Urban Forest grant application and awards.

Fire Suppression is conducted with the sole purpose of limiting the overall impacts of large damaging wildfires. Suppression activities are not sensitive to community composition areas being threatened by these wildfires. Firefighter and public safety are of the highest importance during wildfire suppression. At the same time, smoke and other pollutants can be blown by the wind across communities distant from the actual fire. Poor quality air due to wildfire can aggravate lung and other diseases, as well as lessen the quality of life of every citizen in the smoke's path. For this reason, from an environmental justice standpoint, it is paramount to have rapid control of wildfires.

Similarly, use of prescribed fire can reduce fuels and the risk of wildfire, but can have adverse air quality impacts over a large area. For this reason, use of the practice is limited to days where atmospheric conditions will dissipate smoke. Other restrictions also are imposed by forestry and air quality agencies.

Forestry is a highly regulated activity in California. The harvesting of timber is directly regulated by the California Forest Practice Act and Rules. This regulatory framework includes compliance with CEQA. Other compliance requirements for air quality, water quality, and endangered species are applied by the appropriate state and federal agencies. In all of these processes public disclosure and participation is a mandate.

These same regulatory processes provide an additional avenue to address EJ concerns. EJ concerns are often related to impacts that may occur from project related environmental impacts. An example would be the previous discussion on the potential environmental and Environmental Justice impacts related to the use of herbicides in forest management projects.

Identified impacts to small business would be positive. Activities related to forest management projects will result in an increased demand for equipment and operators to implement reforestation, forest management, urban tree planting, and fuel hazard reduction projects. A small positive impact will result as businesses that bundle and sell carbon offsets develop. This bundling of carbon credits will increase the amount of product available on the market.

Related Objectives

The measure is motivated by multiple benefits. Improved fuels management provides benefits through improved water quality, wildlife habitat diversity, improved air quality, and reduced risk to life and property. The vegetation management treatments used for reducing fire hazard also aid in maintaining a healthy forest that provides all of the associated economic and ecosystem service benefits. The bioenergy component of the measure helps to meet the state's bio-power and bio-fuels targets, reducing reliance on fossil fuels and imported energy. Of particular interest

in this measure is the contribution made to limiting increased erosion that would transport through the natural watercourse system to water storage facilities. Reducing water borne sediment will assist in maintaining water storage facility capacity. This will become increasingly important as climate change advances and California has less ability to rely on snow packs for water storage. From the emissions aspect decreasing episodic events of severe air pollution over or near highly populated metropolitan areas decreases health impacts to the elderly, diseased, and young.

Measure Metrics

The three metrics for tracking the implementation of this measure are:

- Acres Treated: The number of acres treated annually tracks the fuel hazard reduction activity accomplished. This is the primary metric as it drives both the reduction in fire hazard as well as the production of biomass for bioenergy production.
- Biomass Removal: The amount of biomass removed annually tracks the biomass available for bioenergy production.
- Bioenergy Production: The amount of added capacity for producing bio-power and bio-fuel from forest-derived biomass indicates the ability to promote the use of this biomass for displacing fossil fuels.

Measure Goals and Potential Implementation Approaches

As described above, this measure is comprised of two main parts: (1) fuels treatment through state funding and in coordination with federal forest management activities; and (2) promotion of bioenergy production from fuels-treatment and forest health-derived biomass. Each is discussed in turn.

(1) Fuels treatment accomplished through state funding and coordination with federal forest management activities.

This component of the measure is driven primarily by the funding available to support fuel hazard reduction treatment. The amount of land on which treatment can be performed is a function of the funding available and the treatment cost per acre. Per-acre costs vary widely depending on treatment prescription, volume and type of fuel being removed, equipment configuration, site conditions, and other factors (USDA Forest Service Research & Development/Western Forestry Leadership Coalition 2003). For purposes of this analysis, the amount of treatment that can be supported is estimated based on a cost of $400/acre as an average cost of harvest and removal to the roadside. This value is based on CFIP cost-share cap rates (CFIP Users Guide 2005), and we recognize that additional costs will be incurred to cover the full cost (chipping and transport) to move the fuel to a bioenergy facility. This additional cost would be associated with the operation of the bioenergy facility, discussed below.

The following funding sources are identified to date. Additional funding would enable additional activity to be undertaken.

- Existing Proposition 40 Bond Funds: CAL FIRE will continue to use Proposition 40 bond funds to support fuel reduction activities that protect watersheds and water quality, which is estimated at $5 million annually for 2007, 2008, and 2009. This funding will cover approximately 12,500 acres of treatment per year for three years (at $400/acre). Fifteen

Sierra Nevada counties are eligible for Prop 40 fuel reduction, corresponding roughly to the LCMMP regions of Northern Sierra and Southern Sierra.

- Additional Fuels Management Funds: CAL FIRE will work to secure support for a new round of funding for watershed protection via fuel hazard reduction, in order to replace the Proposition 40 funding when it runs our in 2009. It is assumed that this funding will also be for five years (2010-2014), at similar funding levels ($5 million per year), providing funding for fuel reduction in 15 Sierra Nevada counties. This funding will cover approximately 12,500 acres of treatment per year for five years in the eligible counties.
- Proposition 84 Bond Funds: Passed by California voters in November 2006, Proposition 84 allows the state to sell $5.4 billion in general obligation bonds for safe drinking water, water quality, and water supply; flood control; natural resource protection; and park improvements. The amount of funds that may be available for fuel hazard treatment is not known at this time. For purposes of this analysis, we assume that:
  - Of the $315 million devoted to wildlife habitat protection and forest conservation (Chapter 6), most of these funds will be spent for land acquisition and related costs. A small percentage, 10%, or $31.5 million, is assumed to be allocated to fuel hazard reduction to protect the value of investments in forest/habitat.
  - Of the $25 million devoted to the California Conservation Corps for public safety and community fuel load reduction (Chapter 5), 25% is assumed to be for fuel reduction.

  The $37.75 million in total funding from these two sources is assumed to be spread over 13 years (2008 to 2020), for approximately $2.9 million per year. This level of funding supports treating approximately 7,260 acres per year from 2008 to 2020.
- CFIP Augmentation: The California Forest Improvement Program (CFIP), created through legislation in 1978, provides technical and financial assistance to eligible landowners (primarily non-industrial private forest landowners with holdings under 5,000 acres) for forest management activities that improve the quality and value of forestland. There is a range of forest improvement practices eligible for CFIP assistance, including fuel reduction.[2] The program provides cost-sharing of 75% and in special cases up to 90% (CFIP Users Guide 2005). We assume that a stable level of CFIP funding is provided at $5 million annually, beginning in 2008 and continuing through 2020. This amount of funding is an increase from recent levels. Because CFIP is a multi-purpose program, we assume only 25% of CFIP funds or $1.25 million per year for 2008-2020 are devoted to fuel hazard reduction. At the 75% cost-share level, this effectively would make $1.67 million per year available for fuel hazard reduction on non-industrial private forest lands. With this level of funding, approximately 4,167 acres can be treated per year.

Nearly 24,000 acres per year could be treated from 2008 to 2014. After 2014, approximately 11,500 acres could be treated annually with the estimated funding.

The second component of this implementation approach concerns efforts to maintain or increase the number and scale of federal fuel hazard reduction treatments. Federal land management agencies including US Department of Interior (National Park Service, US Fish and Wildlife Service, Bureau of Land Management, and Bureau of Indian Affairs) and US Department of

[2] For purposes of CFIP, fuel reduction is defined to include the practices of pre-commercial thinning (reducing the number of stems of small commercial tree species to a predetermined spacing to improve growth and/or to reduce fuel loads), release (removal of competing non-commercial tree species or shrubs) and pruning (removal of branches to a minimum height of 10 feet or ½ of the Live Crown Ratio).

Agriculture (US Forest Service) have been treating on average around 224,000 acres per year for fuel reduction over fiscal years 2003-05 (D. Cromwell, CAL FIRE, personal communication, 11/29/06). However, for this analysis we conservatively exclude area treated using prescribed fire. Excluding prescribed fire and considering only mechanical treatments potentially yielding usable biomass, federally funded Wildland Urban Interface (WUI) and other projects in California over fiscal years 2003-06 totaled some 572,000 acres and averaged 143,000 acres per year. Although this treatment level may be increased, we assume it will be maintained.

The biomass produced per acre can vary significantly based on site-specific conditions. A useful average of 13 bone dry tons/acre (BDT/acre) has been suggested (D. Wickizer, CAL FIRE, personal communication, 11/27/06). Associated with this biomass production is an estimate of the potential bio-power production. A reasonable rule-of-thumb is that 8,000 bone dry tons of biomass are required per megawatt (MW) of electricity production capacity, assuming an 85% utilization rate (T. Mason, TSS Consultants, personal communication, 12/4/06).[3] Approximately 250 MW of bio-power production capacity can be supported by the biomass produced from these state-funded and federal fuel hazard treatment activities in 2020. The majority of the estimated biomass produced is expected to be associated with federal activities, which would account for the majority of the acres treated.

Non-Quantified Stakeholder Suggested Measures

Two Stakeholders meetings were held in February to request submission of recommended measures to meet the AB 32 GHG emission reduction targets for 2020. Several measures were brought forward that would assist in reducing the risk of large damaging fires. However, the stakeholders were not prepared to quantify the GHG benefits of these recommendations. Department of Forestry and Fire Protection Staff have not had the time to analyze these recommendations due to the timelines on this process.

- Risk based fire insurance: The recommendation was made that insurance companies assess higher fees for structures where fire hazard has not been minimized through use of fire resistant building materials, vegetative clearances, improved ingress and egress, adequate water supply, and proper signing. It will require significant time to develop an analytical process capable of determining the GHG benefits of such a measure. Statutory amendments will be needed in the Insurance Code to enable insurance companies to implement this recommendation.
- It was recommended that additional funding be provided to implement a more aggressive Fire Prevention Program. This is an overarching recommendation that touches many agencies and aspects of this measure. Fire Prevention is composed of three components 1) Education, 2) Law Enforcement, and 3) Engineering. This encompasses a wide variety of actions such as building standards, land-use planning, vegetation management, clearance standard enforcement, and media advisories. An analytical methodology to quantify the GHG benefits of the application of multiple actions does not exist. However, experience has shown that where a comprehensive fire prevention program is in place there is a reduction in fire ignitions, and a reduced amount of property damage.
- There is a recommendation to increase the use of prescribed fire. Additional research is needed in this area to quantify the benefits of frequent small fires replacing large damaging fires. California is a Mediterranean climate that is historically a fire-adapted.

[3] An 85% utilization rate implies 8,760 hours per year x 85% x 1 MW = 7,446 MWh of generation/year.

Starting in the 1940's wildland fire suppression became more aggressive. One result of the increased suppression efforts is a build-up of wildland fuels. Over time this has resulted in a landscape that burns less frequently but, when it burns, it is more intense and damaging. The recommendation suggests that once this over abundance of fuels is removed through mechanical means, subsequent prescribed fires would be a cost effective means of maintaining a lower risk of large damaging fires. Currently there has been a reduction in the use of this tool due to air quality regulations and the logistics of resources used to implement prescribed fire. Research will be needed to validate the GHG benefits of multiple small fires versus infrequent large fires.

- Post fire vegetation management was recommended. The premise is that if you manage vegetation following a large fire, the conditions under which the fire initially burned have changed and the risk reduced for a recurrence of the large damaging fire. The cost of managing vegetation following a fire is a maintenance task and much less expensive that the removal of large volumes of vegetation accumulated over time. In many ways this would be a no regrets policy, but the actual GHG benefits cannot be shown until the research is completed on this measure.

(2) Promotion of bioenergy production from fuels-treatment and forest health-derived biomass

The second component of this measure is to promote the production of biomass and bioenergy to support the goals of the Bioenergy Action Plan. The measure is defined by the amount of biomass needed to fulfill the state's goals for producing biomass fueled electricity (i.e., bio-power) and biomass derived liquid fuel (i.e., bio-fuel).

Bio-Power: Currently, 28 biomass power plants in California use approximately 4 million dry tons (MDT) of solid biomass per year to generate 615 megawatts (MW) of baseload electricity. These plants burn an array of feedstocks, including forest fuels, wood processing residues, municipal solid waste, agricultural and horticultural residues, recycled material and other feedstocks. With an additional 360 MW from landfill gas and biogas (sewage treatment, food waste and animal waste), California's current bio-power total is about 975 MW, meeting about 2% of the state's electricity demand (CEC 2006c).

In order to achieve the state's bio-power objectives, including the Renewable Portfolio Standard, we estimate that 1,450 MW of new bio-power capacity is needed by 2020, including 1,100 MW from solid biomass (with the remainder from landfill gas and biogas). For 2010, approximately 350 MW of new bio-power capacity is proposed (CEC 2005, 2006c). At a rate of 8,000 BDT/MW, the solid biomass required to support these goals for new bio-power capacity are 2.8 MDT/y in 2010 and 8.8 MDT/y in 2020. Given the 615 MW of existing capacity, the total biomass production required (new and existing) is 7.7 MDT/y in 2010 and 13.7 MDT/y in 2020.

The state's technical potential for producing suitable solid biomass exceeds the levels required to achieve these goals. Current production potential is estimated at 30 MDT/y. This technical potential is expected to increase to 34 MDT/y by 2010 and 38 MDT/y by 2020, due primarily to energy crops as well as slight growth in agricultural residues and municipal waste (CEC 2005, 2006c).

Forest biomass produced through fuel hazard reduction can be used to support this increased capacity for bio-power production. The Bioenergy Action Plan reports that forestry residues would constitute 44% of all solid biomass production in 2010 and 41% in 2020, in terms of technical

potential (CEC 2006c). The sources of forest residue include: mill residues (23%); forest thinnings (29%): logging slash (30%); and chaparral/shrub (18%) (CEC 2005). We estimate that fuel hazard treatment can be conducted to produce the forest thinnings, chaparral/shrub, and ½ of the logging slash, or 62% of the technical potential for forestry residues.

Using this 62% figure, the desired biomass production from fuel hazard reduction is estimated to be:

For 2010:	7.7 MDT/y x 44% from forest residues x 62% from fuel treatment = 2.1 MDT/y
For 2020:	13.7 MDT/y x 41% from forest residues x 62% from fuel treatment = 3.5 MDT/y

Although the rate of biomass production per acre varies with site-specific conditions, we use an average of 13 BDT/acre to estimate the total acres required to be treated to support this level of bio-power production at approximately **162,000 acres/year in 2010** and **268,000 acres/year in 2020**. This amount of treatment is similar to the state-funded and federal treatment levels described above for 2010, and exceeds those levels in 2020. Table 1 presents a summary of these calculations.

Table 1: Summary of Estimated Treatment Acres to Support Bio-Power Production

	Units	2010	2020
New bio-power capacity additions to meet state goals	MW	350	1,450
Total (new + existing) bio-power to meet state goals	MW	965	1,715
Solid biomass, all types, required for total bio-power capacity	MDT/y	7.7	13.7
Proportion of forestry residues in total solid biomass	%	44%	41%
Proportion of forestry residues supplied by fuel treatment	%	62%	62%
Forest fuels required for total bio-power capacity	MDT/y	2.1	3.5
Average dry ton/acre removal in fuels treatments	DT/acre	13	13
Annual fuel treatment area needed to supply total (new + existing) bio-power capacity	acres/y	161,709	267,795

The bio-power production impacts can be calculated from these values. The additional bio-power capacities in 2010 and 2020 are 350 MW and 1,450 MW respectively. The portions associated with the fuel hazard treatment in this measure are:

For 2010:	350 MW x 44% from forest residues x 62% from fuel treatment = 95 MW
For 2020:	1,450 MW x 41% from forest residues x 62% from fuel treatment = 368 MW

Using a capacity factor of 85%, the GWh produced in 2010 is 710 GWh in 2010 and 2,740 GWh in 2020.

Bio-Fuel: The contribution of forest residues to bio-fuel production can be estimated in a manner that is similar to the estimates performed for bio-power. The Bioenergy Action Plan set a target of 1.2 billion gallons per year (gall/y) of bio-fuels used in California by 2010 and 2.0 billion gallons/y by 2020. Executive Order S-06-06 sets in-state production goals of 240 million gal/yr (20%) by 2010 and 800 million gallons/y (40%) by 2020. These levels of production are well within the state's estimated technical potential from available cellulosic biomass of 2.6 billion gall/y of ethanol in 2010 and 2.9 billion gall/yr in 2020 (CEC 2006c). Biomass from forest thinnings alone has the technical potential to yield 990 million gall/y of lignocellulosic ethanol, or a quantity exceeding the in-state production target (CEC 2006d).[4]

To achieve the California in-state biofuels production targets, assuming an average yield of 75 gal/dry ton of biomass, will require 3.2 million dry ton/year (MDT/y) in 2010 and 10.7 MDT/y in 2020 including all types of solid biomass. We assume that in the long term as lignocellulosic biomass conversion technologies mature, forestry residue can supply an increasing portion of this biomass due to the abundance of these feedstocks in California combined with the high value of agricultural land and water. The appropriate percentages for the forestry contribution are open to debate; here, we propose that 25% of lignocellulosic biomass used for in-state biofuels production will be forestry-related in 2010, but that by 2020 this proportion will increase to 50%.

As for the proportion of forest fuels within forestry residues, we include no logging slash (inappropriate composition for existing bio-fuels conversion technologies) and no mill residues (although appropriate for bio-fuel production, this biomass is not but directly part of this measure). We include all forest thinnings and chaparral/shrub (may need to be debarked and clean-chipped for bio-fuels production). The resulting proportion of forest fuels within forestry residues is 47%. With these assumptions, total forest fuels needed to meet in-state bio-fuels production targets will be 0.4 MDT/y in 2010 and 2.5 MDT/y in 2020.

For 2010:	240 million gall/y / 75 gal/ton x 25% from forest residues x 47% from fuel treatment = 0.4 MDT/y
For 2020:	800 million gall/y / 75 gall/ton x 50% from forest residues x 47% from fuel treatment = 2.5 MDT/y

Using the same average removal of 13 BDT/acre for fuel hazard reduction, meeting the in-state bio-fuels production targets for 2010 and 2020 will require treating 29,000 acres/y in 2010 and 192,000 acres/y in 2020.

The bio-fuel production impacts can be calculated from these values. The bio-fuel production associated with the fuel hazard treatment in this measure is:

For 2010:	240 million gal/y x 25% from forest residues x 47% from fuel treatment = 28 million gal/y
For 2020:	800 mln gal/y x 50% from forest residues x 47% from fuel treatment = 187 mln gal/y

The estimated total acres treated for the bioenergy portion of the measure is larger than the total acres estimated for the state-funded and federal treatment activities. In order for these levels of activity to be achieved, the demand for bioenergy must materialize, and the capacity to produce and use the biomass must be built.

[4] Lignocellulosic biomass, also called cellulosic biomass, is a general term for biomass that is not food or feed, such as woody biomass, perennial grasses, and the non-food components of traditional agricultural crops.

4. Technology

This measure relies on two groups of technologies, for fuels management and biomass energy production respectively.

Fuels Management: Proven technologies to reduce forest fuel loading vary widely depending on site-specific factors. We focus here on the approaches and technologies that allow removal of biomass, due to the additional GHG benefit from fossil fuel displacement and additional revenues from bio-power and bio-fuels markets. Other approaches are available that do not remove biomass but still reduce fuel loads and thus wildfire GHG emissions. Some of the alternative approaches will be technically or economically preferred for lands that are too steep, too rugged, or too distant from biomass facilities or for other reasons not treatable using a technology that removes biomass. Prescribed fire, mastication, and pile-burning are examples.

The initial step of harvesting understory fuels may be accomplished by skilled hand crews. Other fuels, such as heavy brush, may be harvested using bulldozers or excavators. Removal to a roadside landing is done with tracked or rubber-tired skidders, forwarders, or cable systems, with the technology choice dependent on terrain, distance moved, material size and value. This technology is most often not yet cost effective but the Department is working with University of California at Davis in defining equipment development needs. Equipment choice is also affected by the need to minimize ground damage and erosion potential for the slope and terrain conditions being treated.

Commercial sawtimber suitable for processing will be loaded on log trucks, either using a log loader or self-loading log trucks, for transport to wood-processing facilities. Non-commercial or "submerchantable" biomass, including small trees, slash from merchantable trees, brush and understory vegetation, will be put into chippers, tub grinders or other equipment appropriate for the fuel been removed. Chips are transported in chip vans – tractor-trailers designed for efficient loading and unloading using truck lifts at the bioenergy facility (USDA Forest Service Research & Development/Western Forestry Leadership Coalition 2003).

Bioenergy: Proven technologies to convert solid biomass fuels to electricity are currently in use. California's current biomass-fueled electric generating plants use conventional, direct-fired combustion to produce steam for turbines generating electricity at net thermal conversion efficiencies in the range of 20-28% (CEC 2005). These plants burn a broad array of feedstocks, including forest fuels but also wood processing residues, municipal solid waste, agricultural and horticultural residues, recycled material and other feedstocks. Some generators are sited at wood-processing facilities and are cogeneration technologies, using wood-processing and forestry residues to generate a portion of the plant's electricity and process heat, steam or hot water for lumber kilns.

Other potential bio-power conversion technologies include: co-firing biomass in coal-fired power plants (not common in California, but prevalent in other regions where forest fuel reduction is needed, and providing efficiency gains, GHG and criteria pollutant reductions); combined heat and power (CHP) applications; smaller, distributed generation systems; and biomass integrated gasification combined cycle (BIGCC) plants, offering efficiency improvements (CEC 2005, 2006c, d).

Biofuels: Technologies for conversion of lignocellulosic biomass into transportation fuels (fuels that can be substituted or blended with conventional petroleum-based transportation fuels) are at much earlier stages of technological and commercial maturity than bio-power technologies. Currently, the state has only very small production capacity in conventional biodiesel (16 mln

gal/y) and conventional ethanol (35 mln gal/y, with additional capacity planned).[5] Neither of these processes is suitable for producing bio-fuels from the woody biomass removed from forests for fuel hazard reduction. Rather, bio-fuels will be produced from lignocellulosic components of plant material through thermochemical and biochemical processes.

Lignocellulosic biomass can be converted to ethanol through a biochemical process, using acid or enzymatic hydrolysis to separate cellulose and hemicellulose from lignocellulosic material and create sugars, followed by fermentation of the sugars into ethanol. Lignocellulosic biomass can also be converted to ethanol or other biofuels through thermochemical pathways, using gasification to produce a syngas followed by Fischer-Tropsch synthesis (the "biomass-to-liquids" pathway), to produce gasoline and diesel hydrocarbon substitutes. Another thermochemical option is to use pyrolysis to produce liquid fuel directly, though the outputs of this process are less amenable to conversion into transportation fuels. All of the technologies to convert lignocellulosic biomass into biofuels that can be integrated into refinery feedstock and/or directly blended in transportation fuels require additional research and development efforts and remain to be demonstrated at commercial scale (CEC 2005, 2006c, d). This measure assumes that the technology is developed over time to support this bio-fuel production. Such development will be needed to achieve the goals of the Bioenergy Action Plan.

5. Statutory Status

The following areas will or may need to be addressed:

- The California Forest Improvement Program (CFIP) is authorized in Public Resources Code 4790 through 4799.04 and authorizes the Department to provide technical and other assistance (cost-share funding) to private landowners with ownerships 5,000 acres and under. These lands must have tree canopy cover greater than or equal to 10% or be capable of supporting such a tree cover. Some amendments of this set of statutes may be needed to allow use of state funds on larger private land ownerships and for state lands, if further discussion reveals a need.

Additional actions that would facilitate this measure include:

- Implementation by the Public Utilities Commission of the accelerated Renewable Portfolio Standard (RPS) for investor-owned utilities of 20% renewables by 2010 and 33% by 2020, and within these RPS goals, implementation of the Executive Order S-06-06 target of 20% electricity from biomass.
- Implementation by the Energy Commission of similar RPS targets for the State's municipal utilities.
- Tax incentives, similar to those in the Timberland Production Zone model, to encourage landowners to implement fuel hazard reduction projects.
- Ongoing priority and funding for improved data collection, mapping and monitoring, including the Department Fire and Resource Assessment Program (FRAP) land cover change monitoring.

[5] Conventional biodiesel means a biofuel from transesterification of plant oils suitable for use in compression ignition (diesel) engines. Conventional ethanol production means bioethanol fermented from starch and sugar crops (CEC 2006d).

6. Implementation Steps and Timeline

Each of the implementation approaches listed above is addressed individually below.

1. *Bioenergy Action Plan.* The Department and other state agencies have specific assignments with timelines set forth in the Bioenergy Action Plan of July 2006 (CEC 2006b).
2. *Coordination of Federal and State fuel treatments*. The Department will work on an ongoing basis with other state agencies to encourage our federal partners to maintain or increase the number and scale of fuel hazard reduction treatments in California. Part of this effort will be seeking joint projects that provide watershed-level protection.
3. *CFIP augmentation.* To implement the CFIP augmentation portion of this measure, the Department will:
    a. Identify and secure adequate funding to support cost-share projects.
    b. By July 1, 2008 begin funding Fuels Management/Biomass projects on private land.
    c. January 1, 2009 provide a monitoring report summarizing the acres of Fuels Management/Biomass with a projection of carbon sequestration.
4. *Support for continued federal action.* The Department will work with other state agencies to develop an approach for state legislature consideration that would encourage the federal government to maintain or increase the amount of funding provided to National Forests in California for fuel hazard reduction treatments. This will begin in 2007.
5. *Outreach.* Beginning mid-2007, start an outreach to other state agencies to provide technical assistance for fuel hazard reduction.
6. *Programmatic Environmental Impact Report for the Department vegetation treatment programs.* The programmatic EIR is expected to be completed in late 2007, providing CEQA review for the department's entire suite of vegetation treatment programs. This should significantly simplify the environmental analysis required at the project level, facilitating planning and implementation of individual fuel hazard reduction projects.

In addition to these specific implementation activities, we also highlight the need to develop protocols for accounting for the carbon impacts of these forest-related activities. The creation of a mechanism for selling carbon emission reductions is an important element of promoting forest practices that reduce emissions, sequester carbon, and have multiple other benefits.

7. Greenhouse Gas Emission Reductions

As described above, this measure reduces GHG emissions through two primary mechanisms:

- Through hazardous fuel treatment, the frequency and severity of wildfires will be reduced. As a result, CO_2 emissions will be reduced and more carbon will remain in forest biomass.
- The fuel (biomass) removed as part of the treatment can be used to produce electricity and liquid fuels. This biomass-based energy can displace the use of fossil energy (natural gas for electricity production and petroleum-based gasoline), thereby displacing the GHG emissions from the use of these fossil fuels.

The GHG emission reductions due to displacing fossil fuels in the production of electricity (MWh) and liquid fuels are estimated using a common set of emission factors that was adopted for the overall analysis of all the climate strategies. The emission factors and GHG emission reduction estimates are presented separately.

Here, we focus on the reduced GHG emissions due to reductions in the frequency and severity of wildfires. A methodology for estimating the benefits of reducing wildfire emissions through fuel treatment is being developed under the WESTCARB partnership. The following is a first-order estimate based on available information.

To estimate the benefit of reducing emissions from wildfires through fuel treatment, three factors were considered:

- mean number of fire ignitions per acre of forest;
- mean area of forest fires in acres (following an ignition); and
- GHG emissions per acre burned.[6]

Twenty years of fire data were used to make these estimates (1986 through 2005). To account for geographic variability, the State was divided into the five Land Cover Mapping and Monitoring Program (LCMMP) regions (see http://www.frap.cdf.ca.gov/projects/land_cover/index.html). Table 2 presents the estimates of ignitions per acre per year, mean fire area, and mean emissions per acre from fires.

Using the figures in Table 2, we can calculate the average GHG emissions per acre per year in each of the five regions, and an average across the regions. The average emissions per acre per year is calculated as:

Average GHG Emissions Per Acre Per Year	=	Mean # of ignitions per acre per year	x	Mean fire area in acres per ignition	x	Mean emission per acre burned

Table 3 presents the average emissions per acre per year for each region, and an average for the regions. An average is also shown for the North and South Sierra regions as the Proposition 40 funding is only applied to those two regions.

For the purpose of this analysis, the assumption is made that ignitions per acre per year remain constant as do emissions per acre. The impact of fuels treatments is therefore assumed to be on the area that will burn as a result of a wildfire. Treatments slow the progression of fires and restrict fires to the understory where they can be contained and extinguished. Based on the Department case studies and the Department expert opinion, the assumption is made here that fuels treatment will reduce area of a potential fire by 50% (D. Wickizer, Department, personal communication). The resulting reduction in annual emissions per acre as a result of the treatment is shown in Table 3 as one-half of the emissions that are expected in the absence of treatment.

This approach is *highly* conservative because it makes the assumption that fire ignition will only occur in the treatment area, while in the majority of situations fires will begin outside the area and burn into the area. This assumption greatly reduces the area over which potential ignitions are

[6] Greenhouse gas (CO_2, CH_4 and N_2O) emissions from forest land burned over the 20-year period for the five Land Cover Mapping and Monitoring Program regions were calculated using California Air Resources Board (ARB) methods for estimating emissions from wildfires (Battye and Battye, 2002). These methods use the Emission Estimation System (EES) model and table of emission factors. The EES Model overlays fire perimeters on a California vegetation map (Davis et al. 1998) to estimate proportions of vegetation types consumed by each fire. The model uses fuel load characteristics for the fuel components of each vegetation type, derived from the First Order Fire Effects Model (FOFEM) (Reinhardt et al, 1997). The FOFEM model determines pre-burned fuel loading, fuel mass consumed, and smoke emissions generated per fire acre burned. There are ten fuel components by vegetation type, and the EES model calculates tons of each fuel component consumed by the fire in dry conditions.

considered, lowering the area that is given the multiplier of the average fire size. As the WESTCARB project proceeds, the approach will be refined, and methods will be developed that consider all fire ignitions and the full extent of baseline fire emissions.

The avoided wildfire GHG emissions due to treatment can be calculated by multiplying the average emission reduction per acre times the number of treated acres. The acres treated under Proposition 40 are located in the North and South Sierra regions. Consequently, the average emission reduction for these two regions is applied to the Proposition 40 acres. The emission reduction for all other treated acres is estimated using the five-region average in Table 3. The resulting estimates are presented in Table 4.

Approximately 53,000 tons of GHG emissions would be avoided in 2010 and about 91,000 tons avoided in 2020. The overall emission impact of this measure is driven primarily by the emissions avoided due to bioenergy production, with the avoided wildfire emissions (reported here) being smaller by comparison. The avoided fossil fuel emissions are presented separately.

The uncertainty in the mean estimates of ignitions, burned area, and emissions is approximately 15%. However, this uncertainty does not incorporate errors in the estimation of the emissions nor in the recording of fire areas. As mentioned above, the accounting of fire damage remains incomplete because fire ignitions are only included from within the treatment areas. The direct emission reductions, therefore, could be substantially higher than reported here.

Table 2: Mean Ignitions Per Acre Per Year, Fire Area, and Emissions Per Acre For Forestland in Five Regions of California

Region	Mean # ignitions per acre per yr	+/-95%	Mean fire area (acres)	+/- 95%	Mean emission per acre burned (tons CO_2e)	+/- 95%
North Coast	0.0000023	0.0000032	1,637	3,637	57	35
Cascades Northeast	0.0000021	0.0000031	2,193	5,960	55	54
North Sierras	0.0000040	0.0000047	1,496	3,464	46	31
South Sierras	0.0000048	0.0000039	1,338	2,971	39	30
South Coast	0.0000043	0.0000033	5,757	14,087	20	20

Table 3: Average Emission Rate and Reduced Emissions Due to Treatment

Region	Average Annual Emissions Rate (Tons CO_2e per acre)	Reduced Annual Emissions Due to Treatment (Tons CO_2e per acre)
North Coast	0.21	0.11
Cascades Northeast	0.25	0.13
North Sierras	0.28	0.14
South Sierras	0.25	0.13
South Coast	0.50	0.25
Average of 5 Regions	**0.30**	**0.15**
Average of North and South Sierras	**0.26**	**0.13**
Calculated from the data in Table 2.		

Table 4. Greenhouse Gas Emissions Impacts Summary

	Direct Emissions Impacts	Energy Impacts	
Year	Emissions Avoided from Wildfires (tons of CO_2e)	Electricity from Bio-Power (GWh)	Displaced Gasoline from Bio-Fuels (million gallons)
2020	**91,489**	**4,609**	**126**
Cumulative	**915,307**	**50,192**	**794**
1. Bio-fuel is estimated to have approximately 67% the energy value of gasoline. The volume of displaced gasoline is calculated to be 67% of the bio-fuel production.			

8. Costs and Cost Savings

This section presents the costs and cost savings associated with this measure. The costs are estimated for the individual pieces of the measure including:

- performing the fuel hazard reduction treatments;
- preparing and transporting the fuel to the bio-power or bio-fuel facility;
- building the bio-power and bio-fuel facilities;
- operating the bio-power and bio-fuel facilities;
- measuring the direct GHG emission impacts of the fuel hazard reduction treatments.

Two types of cost savings are estimated. First, the fuel hazard reduction treatments reduce wildfires and consequently reduces fire suppression costs. Second, the bioenergy produced

displaces fossil fuel energy, thereby saving the cost of those fossil fuels. The value of the displaced fossil fuel is estimated using a consistent set of energy prices across all the strategies, and consequently is presented separately.

Table 5 presents the cost and saving factors used for this measure. The basis for each of the cost factors is as follows.

- Treatment Cost: The treatment cost varies based on site specific conditions. As discussed above, an average cost of $400 per acre is used.
- Fuel Preparation and Transportation: This cost covers the activities required to prepare and transport the fuel to the bioenergy plant. We adopt an estimated fuel cost of $40/BDT based on the following. At $0.35/BDT-mile haul cost, transporting fuel up to 50 miles would cost up to $17.50/BDT. The other $22.50/BDT, at 13 BDT/acre removal level, would provide an additional $293/acre toward treatment and chipping costs, bringing the total for mobilization, harvest, removal to roadside, and chipping to $693 ($293 plus $400), a figure compatible with regional averages (USDA Forest Service Research & Development/Western Forestry Leadership Coalition, 2003). This cost estimate is at the high end of fuel prices paid over recent decades.
- Capital Cost for New Fuel Treatment Capacity: The amount of fuel treatment anticipated in this measure is a significant increase from current treatment activity. Consequently, we include the capital cost of expanding the fuel treatment industry. The full set of equipment for an efficient fuels treatment operation generally represents at least a $1 million investment (S. Jolley, Wheelabrator Shasta Energy Company, personal communication). We assume that a fully equipped fuel treatment operation working throughout the season could treat approximately 15,000 acres per year.
- Bio-Power Capital Costs: Capital costs for new bio-power capacity range from $1,500 to $3,000 per kW installed (CEC 2005), or for a new 25 MW facility, $37.5 to $75 million. We use a midpoint capital cost of $2,250/kW.
- Bio-Power Non-Fuel Operating Costs: The non-fuel operating costs are estimated at $0.06 per kWh.
- Bio-fuel Capital Costs: Capital costs for lignocellulosic ethanol or F-T liquids production facilities are difficult to estimate due to the relative immaturity of these technologies and lack of commercial-scale production facilities. Economies of scale will be important as the industry develops. We use an estimate of $200 million for a 50 million gallon per year facility based on IEA (2004).
- Bio-fuel Non-fuel Operating Costs: Similar to capital costs, the operating costs for bio-fuel production are difficult to estimate due to the relative immaturity of these technologies and lack of commercial-scale production facilities. We use an estimate of $1.00 per gallon of bio-fuel produced based on IEA (2004).
- Carbon MMV Costs: A critical aspect of this measure is that it be motivated by carbon reduction goals. Consequently, monitoring, measurement, and verification (MMV) of the GHG emission impacts of the measure are central to its success. The cost to qualify fuels management activities for carbon markets is currently unknown. Past experience has suggested a MMV cost of about $1 per acre per year, varying by project type and duration (Brown et al. 2004, Dushku et al. 2005). Because this measure is new and relatively complex, we assume a conservatively high MMV cost of $3 per acre per year.

Applying these cost factors to the acres treated, bio-power capacity built, bio-power generated, bio-fuel capacity built, and bio-fuel produced results in the cost estimates presented in Table 6. These costs total approximately $13 billion through 2020, including all capital and operating costs.

Substantial savings are realized due to reduced fire suppression costs. These savings are difficult to estimate, as they tend to be anecdotal and counter-factual: how large would a fire have become, and how much more would it have cost to contain, without treatment? The Department and others archive fire case studies and success stories of instances in which fuel reduction treatment is believed to have kept fires smaller, slowed fires, or brought crown fires to the ground where they could be controlled, thus causing substantial savings in fire suppression costs as well as reductions in property, natural resource and other asset losses (D. Wickizer, W. Mitchell, the Department, personal communication, 11/21/06).

Sixteen such case studies were reviewed for this analysis: Goat, Esperanza, Marysville Road, Geysers, Peterson, Widow, Emmons, Old Gulch, Kaweah, Ranch, Winton, Caylor, Fern, Maidu, Guntley and Cone fires. Suppression cost for these fires ranged from $277 to $19,178 per acre. Pre-fire fuel hazard reduction treatments included thinning, biomass chipping, shaded fuelbreaks, prescribed fire, defensible space treatments, and logging. Estimated suppression cost savings attributable to fuel hazard reduction ranged from $200,000 to $5 million. The benefit:cost ratio for fuel hazard reduction (estimated reduction in suppression costs divided by fuel treatment cost) ranged from 13:1 up to 200:1.

We here adopt a conservative suppression cost savings approach, assuming a conservative average suppression cost of $1,500 per acre based on case studies, and assuming as in the case of the GHG methodology that fuels treatment will reduce the area of a potential fire by 50% (D. Wickizer, Department, personal communication). The area treated should result in at least an equivalent area on which suppression at $1,500/acre is avoided. This approach is a first-order approximation, and additional data collection and analysis by the Department is recommended to improve quantification of these cost savings.

Using the savings of $1,500 per treated acre, the savings total more than $9 billion through 2020, offsetting the overwhelming majority of the total cost of the measure. The value of the electricity and gasoline displaced (reported separately) results in the total savings exceeding the total cost of the measure.

Additional savings not quantified here include reduced damages to land, resources/timber, or property. These savings are realized by the land/property owner or their insurer. Assets saved included homes, timber, watershed resources, wildlife habitat, parks, rangeland, and power generation facilities. Due to the huge uncertainty range, no attempt is made in this analysis to include estimates of avoided asset losses due to fuel hazard reduction. Ongoing data collection and analysis by the Department is recommended to improve quantification of this substantial cost savings. Some quantitative information on the value of assets at risk is provided in Appendix C of the California Fire Plan (California State Board of Forestry 1996).

Table 5: Cost Factors

Cost Element	Basis of Application	Cost Factor
Treatment cost	Cost per acre treated	$400
Fuel preparation and transportation cost	Cost per BDT of fuel produced	$40
Capital cost for new fuel treatment capacity	Cost per 15,000 acres	$1,000,000
Bio-power capital cost	Cost per kW of capacity	$2,250
Bio-power non-fuel operating cost	Cost per kWh	$0.06
Bio-power renewable energy subsidy	Cost per kWh	$0.02
Bio-fuel capital costs	Cost per 50 mln gal of capacity	$200,000,000
Bio-fuel non-fuel operating cost	Cost per gallon of bio-fuel	$1.00
Carbon MMV costs	Cost per acre treated	$3.00

Table 6. Cost/Savings Summary

	Costs and Savings (million of 2006 dollars)			Energy Savings[1]	
Year	Capital Costs	Operating Costs	Suppression Cost Savings	Electricity (GWh)	Gasoline (Mill. Gal)[2]
2020	$127	$1,123	$922	**4,609**	**126**

1. The value of the energy displaced is not included in this table. A standard set of energy values is used across all the strategies. The value of the energy saved or displaced is reported separately.

2. Bio-fuel is estimated to have approximately 67% the energy value of gasoline. The volume of displaced gasoline is calculated to be 67% of the bio-fuel production.

9. Other Benefits

Implementation of this measure provides additional benefits in the areas of:

- improved water quality and reduction in the erosion/sedimentation into water bodies that accompanies wildfire;
- protection of wildlife habitat and enhanced habitat diversity;
- improved air quality through reduction in emissions of criteria pollutants; and
- provision of jobs in California's rural economy (forest products and biomass energy industries, and associated businesses serving these sectors).

Of particular note is that wildfires are a major source of criteria pollutant emissions, including reactive organic compounds (ROGs), NOx, SOx, and particulate matter. Fuel hazard reduction programs driven by GHG emission reduction goals, to the extent they reduce the frequency, size, and severity of wildfires, will have substantial co-benefits in reducing emissions of criteria pollutants.

Summary Table. State-funded and federal fuel hazard treatment; fuel hazard treatment to produce biomass to support bio-power and bio-fuel production

Data Elements	2020
Measure Metric Goals	615,000 acres treated 619 MW of Bio-Power Capacity 187 Million Gallons of Bio-Fuel
Greenhouse Gas Emissions Impacts	
MMT CO_2e (emissions impact not associated with fossil energy combustion)	0.09 MMT CO_2e
Fossil Energy Impacts	
Production of non-fossil electricity	4,609 GWh
Production of non-fossil transportation fossil fuel	126 million gallons of gasoline equivalent
Cost and Cost Savings	
Capital costs	$127 million
Annual operating costs and savings	$1,123 million in costs $922 million in savings
Electricity & fuel displaced by non-fossil production (in energy units)	4,609 GWh 126 million gallons of gasoline
Other Benefits	Multiple water quality, air quality, and wildlife habitat benefits. Reduced costs of wildfire to property owners.

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Climate Action Team
Forestry Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

The purpose of this document is to provide the public with information about options considered and analyzed by the Climate Action Team (CAT) Sector Sub Groups for Air Board's consideration and potential inclusion in the Scoping Plan. This information should be drawn from the Measure Analyses previously developed by each Sub Group.

Information should only be updated to reflect significant changes in technology, staff assignments, and understanding of the issues.

Outline

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1. ***Measure: Afforestation / Reforestation (AR)*** *(Planting Trees)*

2. ***Agency:*** California Department of Forestry and Fire Protection.

3. Measure Description

Overview

The strategy has the goal of cumulatively offsetting CO_2 emissions by planting trees on areas suitable for the selected species' establishment and growth. The removal of brush and replanting of conifers is expected to produce emissions initially, but as forest stands develop the GHG benefits increase dramatically. Estimates for the statewide potential for reforestation and afforestation are few and wide ranging. Brown et al (2004a) estimated that 12 to 21 million acres could be afforested at a carbon market price of $13.6 per ton CO2 (i.e. $50/ton carbon) for 20 to 80 year projects. Winrock estimated significant acreage exists in California that could be reforested/afforested at a carbon price of $5.5/ ton CO2 ($20/ton C). For the purposes of this report the Department did an independent analysis using actual program costs. The assumptions are stated later in this paper. The California Climate Action Registry defines reforestation as the establishment and subsequent maintenance of native tree cover on lands that were previously forested, but have had less than 10% tree canopy cover for a minimum time of ten years. Afforestation is defined as ("Dictionary of Forestry", Helms, 1998) the establishment of a forest or stand in an area where the preceding vegetation or land was not forest. CAL FIRE will work with private and public landowners to encourage the planting of trees. Because it is difficult to separate these activities at the scale of this Scoping Plan and because large entities, such as the USFS conduct both types of activities, we are including both reforestation and afforestation in this strategy.
Trees will offset GHG emissions by sequestering carbon from non-discriminate sources (transportation, utilities, industrial, etc.). Trees utilize carbon dioxide in photosynthesis and store a portion of the carbon in the production of wood fiber. The tree bole, limbs, and roots are composed of approximately ½ carbon by dry weight. As the trees grow they will store additional carbon according to the rate of growth and size of tree. Additional carbon will be stored in the soil because the inputs of dead leaves and roots, for example, are higher than the losses from decomposition of this material.

Affected Entities

The affected entities for reforestation/ afforestation include but are not limited to:

Private Landowners: Industrial and non-industrial landowners within California have title over land that has previously grown trees or is capable of growing trees, but that same land is now occupied by brush, herbs, grass or other vegetative land covers. This occurs for a variety of reasons including 1) trees are not compatible with desired land use, 2) natural occurrences such as wildfire have changed the vegetative cover, 3) human activities such as mine smelter operations have killed the tree cover, 4) changes in the micro-climate such that natural re-establishment of trees did not occur. Often these landowners are aware of this opportunity but under current conditions it is not economically feasible to reclaim these previously tree covered lands.

Public Landowners: Approximately 65% of the rangelands (about 15 million acres) in California are under public ownership including owners such as the United States Forest Service, National Park Service, Bureau of Land Management, Bureau of Indian Affairs, Bureau of Reclamation, Department of Parks and Recreation, State Lands Commission, Cal Trans, Department of Water Resources, Department of Fish and Game, and CAL FIRE. Public investment in tree planting on these lands will depend on agency missions and other environmental services such as biodiversity, quality water, wildlife habitat, biomass, and recreational opportunities.

Regulatory Agencies: California has a high level of regulation on private and public forest and range lands. Primary areas of regulation are water quality, air quality, land use, timber harvest and other types of vegetation management. Afforestation and reforestation efforts will require consultation among these authorities to assure that the most carbon storage possible is obtained while still achieving a balance with the other regulatory constraints. AR activities may be subject to local land-use regulations (use permits), State Water Resources Control Boards (Waste Discharge Requirements) and Department of Fish and Game (Streambed Alterations and T&E species). Timber harvesting regulations administered by CAL FIRE require post-harvest restocking, however they do not require replanting of burned areas, and stands impacted by disease and insects. CAL FIRE programs supporting voluntary reforestation are covered by a programmatic EIR.

Non-Profits: California has a rich population of non-profit organizations that are interested or involved with land use and natural resource management. Examples of these organizations are The Nature Conservancy, Conservation Fund, Pacific Forest Trust, Sierra Club, and natural resource and planning professional organizations.

Local Government: Some of California's urban areas contain large open areas that would be suitable for AR efforts. An example would be portions of the San Francisco watershed south of the main city near Crystal Springs Reservoir. Another example would be lands owned by East Bay Municipal Utility District in the East Bay hills.

Environmental Justice, Small Business, Public Health, Leakage and CEQA –

Environmental Justice has been considered from the beginning of the public deliberations on Climate Change by both the California Climate Action Team and the Air Resources Board (ARB). Subsequent to the issuance of the 2006 Climate Action Team Report the State Legislature passed AB 32 (The Global Warming Solutions Act) and the Governor signed the bill. AB 32 became effective January 1, 2007. The bill carried Environmental Justice forward as an interest to be addressed in each of the major emission sectors. Forestry is one of those sectors. ARB established an Environmental Justice Advisory Committee (EJAC) as required by

AB 32. This committee has had numerous meetings that have been advertised on the ARB website. Forestry Sector concerns were discussed in these meetings.

A set of public meetings addressing the Forest Sector were held in February 2008 for the AB 32 Scoping Plan. These meetings were also advertised on the Website to invite public participation. No Environmental Justice Issues were raised during those meeting.

EJAC raised one specific comment in recommendations on ARB Early Actions. Other possible concerns for the Forestry Sector are also listed below. Topics which need consideration for the Forest Sector are:

- The Committee has deep concern about the appropriate use of forest-based carbon sequestration and its potential as a long term solution for meeting California's GHG reduction targets.
- The use of chemicals in forest management activities.
- The use of offsets to permit continued pollution by regulated sectors.
- In Urban areas tree plantings should be appropriately distributed to all communities.
- Fire Suppression efforts should be equal amongst all communities threatened by large damaging wildfires.

The concern that the use of offsets (including forest offsets) will permit continued pollution by regulated sectors is not completely addressed. This issue is still under discussion by the participants in this and other processes. One possible outcome would be some restriction on what the offsets could be used for. Example, if forest sequestration offsets were only allowed to offset Carbon Dioxide, then the criteria pollutants and other harmful substances would have to be dealt with through other mechanisms such as reductions through technology.

There have been repeated concerns expressed about the use of herbicides in forest management activities and the potential impacts on the waters of the state and Native American vegetation gathering The use of the chemicals themselves are regulated by the County Agricultural Commissioners and are only applied in accordance with strict label restrictions developed by the federal EPA. The Regional Water Quality Resources Control Boards both permit and require monitoring of the use of forest herbicides. The California Department of Forestry and Fire Protection conduct either programmatic or project-by-project analysis or mitigation of the use of herbicides under the requirements of the California Environmental Quality Act (CEQA). Together these agencies and processes foster the safe use of herbicides in forest management activities.

There is some concern that tree planting under the California Department of Forestry and Fire Protections (Department) Urban Forestry program may not be evenly applied to all communities. This is addressed in guidelines used by the Department for Urban Forest grant application and awards.

Use of prescribed fire can reduce fuels and the risk of wildfire, but can have adverse air quality impacts over a large area. For this reason, use of the practice is limited to days where atmospheric conditions will dissipate smoke. Other restrictions also are imposed by forestry and air quality agencies.

Identified impacts to small business would be positive. Historically, there was a large infrastructure of timber operators and other occupations related to woods operations. However, for a variety of reasons, the number of operators and infrastructure supporting logging and other forest operations has declined substantially. Many operators were small businesses.

Increased activity related to forest management, reforestation, fuel reduction projects, and even urban tree planting and maintenance probably will result in an increased demand for equipment and operators. This demand could lead to the creation of new small businesses and the retooling of others. A small positive impact also will result as businesses that bundle and sell carbon offsets develop. This bundling of carbon credits will increase the amount of product available on the market.

Finally, regarding leakage, conceptually it is the storage of carbon with one forest activity while a separate activity removes other forest carbon, thus reducing the atmospheric benefit of the original project. Carbon sequestration is subject to two types of leakage. The two types of leakage that may occur with forest projects are "activity shifting" and "market". Activity shifting leakage is dealt with in the Forest Carbon Accounting Protocols adopted by the California Climate Action Registry (CCAR) and the Air Resources Board. Where this type of leakage may occur deductions are charged against the possible amount of carbon storage that may be certified by CCAR. Market leakage is a much more difficult area to address and work on solutions are continuing during the current CCAR review and updating of the Forest Protocols.

Related Objectives

The Measure is Motivated by Multiple Benefits: Afforestation and Reforestation provide benefits of improved water quality, wildlife habitat diversity, improved air quality, energy opportunities, and provision of jobs. Many areas which are being considered for afforestation or reforestation were deforested as the result of frequent wildfire activity which prevented natural regeneration and resulted in conversion to brush or annual grass. These vegetation types, in turn, increase the risk of high intensity wildfires. The wildfires are often followed by erosion which impacts water quality and storage capacity, soil productivity, and fisheries habitat. Reforesting these areas with proper follow-up vegetative treatment reduces the risk of these large damaging fires, since fires in managed stands of timber tend to burn along the ground at low intensities. Reforestation will also benefit native wildlife species.

Measure Metrics

The primary metric for afforestation/reforestation is acreage of trees planted. In addition, costs and benefits are estimated, including CO2 sequestration. The economic analysis includes wood products for those reforestation activities that are likely to result in future commercial harvest. CO2 sequestration is calculated using methodology from the California Energy Commission report, "Methods for Measuring and Monitoring Carbon Projects in California, Winrock International, 2004"[1].

Measure Goals and Implementation Approaches

The following implementation options will require a substantial public and private investment. Funding for tree planting will be provided through either cost share programs or market opportunities for the landowners and possibly public agencies. For example, PG&E has just had a pilot voluntary tariff project approved by the California Public Utilities Commission that has the potential of paying landowners $9.71 per ton of CO_2 sequestered in trees.

Major Initiatives Analyzed

1. Incentive Program: CAL FIRE administers the California Forest Improvement Program (CFIP). The program has had intermittent funding since its commencement in 1981. Since

[1] http://www.energy.ca.gov/pier/final_project_reports/500-04-072F.html

the beginning of the program nearly 52,000 acres have had reforestation treatments. This could be significantly increased with a stable funding source. CAL FIRE will seek funding to establish an annual grant program of $3.5 million. This will not meet the full carbon objective but should result in an estimated 4,242 acres per year. To expand reforestation as proposed for this initiative, additional seed and seedling supplies may be need to be developed. This would require a gradual increase in acres to the desired annual target as programs and nurseries ramp up to meet supply.

2. Offset Program: Developing a market for GHG offsets including forest carbon sequestration as qualifying offsets. Such a market will encourage land owners to reforest areas currently occupied with brush and other vegetative communities and to implement other conservation forest management practices. This measure would result in about 2,000 acres per year of reforestation..

3. The State of California has significant landholdings, including lands that are capable of growing native tree species but are currently occupied by other vegetative cover. CAL FIRE will work with state agencies to identify lands capable of having terrestrial carbon sequestration increased and to implement both afforestation and reforestation projects. This measure proposes that 4,500 acres per year could be afforested on state lands.

4. The USFS plants about 8,600 acres per year on areas that have experienced high intensity fires or severe insect mortality. They have identified a backlog of areas that could be reforested if fiscal and technical constraints were addressed. This measure proposes replanting 15,400 additional acres per year. Based on wildfires between 2001 – 2007, the USFS estimated an average maximum potential need for reforestation at 24,000 ac/yr. Acreage targets are derived from a database of deforested USFS lands. (http://www.fs.fed.us/r5/rsl/projects/postfirecondition/).

5. Reforestation opportunities for mitigating forest and woodland conversions. The measure analyzes potential GHG benefits of having CAL FIRE and local government require mitigation of every acre of forest and woodland converted through reforestation at a rate of 1:1 or 2:1. It would reforest 30,500 acres annually when fully implemented.

Other Initiatives

- CAL FIRE will work with the California Department of Food and Agriculture (CDFA), as mandated by the California Bioenergy Action Plan, to demonstrate the use of trees for salt remediation plantings, windbreaks, and bioenergy crop plantations for biomass energy production.

- Additional nursery production capacity and investment may be needed to provide adequate supplies of seed and seedlings. This includes a supply of more diverse genetic materials to allow for adaptation to changing forest conditions that result from climate change. Initially CAL FIRE will need to increase cone collection and seed storage efforts. The growing of planting stock for reforestation projects will need to involve both public and private forest tree nurseries.

- In addition to the actions described above, CAL FIRE will provide technical assistance to other entities to promote planting. PG&E has recently been approved to proceed with a pilot voluntary tariff that would use ratepayer contributions (via monthly bill increases) to fund

forestry projects that would increase carbon sequestration. CAL FIRE will work with them to monitor the success of this program and encourage the other main utilities within California to develop similar programs. CAL FIRE will also work with the UC Integrated Harwood Range Management Program to promote opportunities for the afforestation and reforestation of hardwood range lands.

- Separate from State efforts, the forest industry in California has a practice of reforesting areas that have been damaged by fire or pest infestations. They also will reclaim old brush fields where the site productivity is high and the economics justify the investment in reforestation efforts. These voluntary activities on private lands that contribute to GHG reductions can be maintained and enhanced with favorable tax policies and other types of incentives.

- Income Tax Credits for landowners (industrial and non-industrial) to plant and retain trees. The amount of credit would vary by types of ownerships and the extent of maintenance and reporting requirements agreed to by the landowner. Credits would be limited to value invested by the landowner. This will require CAT sponsorship and leadership if it is to be accomplished. CAL FIRE will begin development of a legislative proposal for this effort. CAL FIRE also recognizes that the ultimate legislation may be larger than just tax credits for forestry projects.

- Expansion of riparian forests along valley floodplains (measure not analyzed). This measure emphasizes the restoration of riparian forests in valley floodplains. While increasing carbon sequestration through planting riparian trees the measure also has many co-benefits. The measure would provide improvements in flood protection and would create additional habitat for riparian communities. Implementing this measure will require overcoming significant barriers associated with changes in land use.

Other Actions Suggested by Stakeholders:

Two stakeholders meetings were held in February to request submission of recommended measures to meet the AB 32 GHG emission reduction targets for 2020. Additional measures were suggested that could assist in enhancing GHG benefits, however the Department of Forestry and Fire Protection cannot analyze or recommend these at this time.

- Increase private forestland reforestation with revenues from a new Public Goods Charge on virgin paper products and solid wood products.
- Enhance under-utilized and under-stocked lands
- Replanting prior to 10 year limit
- Research and pilot projects
- Additional protocols
- Third party review of projects
- Tracking and documentation
- Communication/education/outreach.

4. Technology

The afforestation/reforestation strategy will be implemented by planting trees on suitable lands, including areas that support conifer and hardwood forests, oak woodlands, and riparian hardwoods. Species selection will depend on habitat type and on site conditions, including changing micro-site conditions from climate change, to the extent that we are able to predict them.

Increased supplies of seed stock and seedlings will be needed to fully implement this strategy. Genetic improvement of nursery materials will be needed to ensure that reforestation activities can address the need for adaptation.

Improved weather and atmospheric models, combined with site-specific tree growth models and GIS analysis will improve our selection of sites where reforestation will be biologically successful and also allow us to evaluate cost-effectiveness, i.e. where the least to most expensive carbon credits would likely be found. This will provide realistic estimates of the potential supply of carbon available as a result of afforestation activities.

5. Statutory Status

The following areas will or may need legislative action:

The California Forest Improvement Program (CFIP) is authorized in Public Resources Code 4790 through 4799.04 and authorizes CAL FIRE to provide technical and other assistance (cost share funding) to private landowners with ownerships 5,000 acres and under. These lands must have a 10% tree canopy cover or be capable of supporting such a tree cover. Some amendments of this set of statutes may be needed to allow use of state funds on larger private land ownerships and for reforestation of other public lands. If further discussion reveals a need and agreement to provide state agencies funding for AR projects, CFIP may be an appropriate program to facilitate project implementation if modified to include public land eligibility. The Governor's Budget includes a $3.1 million augmentation of CFIP which will need to be approved by the Legislature.

The Climate Action Team will need to work with the CAL FIRE to identify potential incentives for those investing in afforestation or reforestation projects, and potential funding sources to provide cost share assistance in afforestation and reforestation efforts.

The establishment of mitigation requirements for CAL FIRE's Timberland Conversion Permit program would be clarified by adding specific authority compensatory mitigation either to CEQA or the Forest Practice Act. Increased mitigation of conversions by local government may require changes to local policies, plans (e.g. General Plans) and ordinances. Statutory changes to CEQA or changes to CEQA guidelines may also be needed.

6. Implementation Steps and Timeline

A. CFIP Augmentation**:**

1) The Governor's 2008/09 Budget includes a $3.1 million expansion of CFIP ($2.8 for projects).

2) Identify additional funding up to the $5 million goal for a ten year program of cost-share projects.

3) Implementation will be phased, given the need to ramp up seed stock and nursery operations. Reforestation on private lands will start with 2,000 acres in 2009, 3,000 acres in 2010, and fully implemented at 4,242 acres per year by 2012.

B. Carbon Market:

1) The establishment of voluntary and cap and trade market programs that permit the use of forest carbon sequestration offsets. Point Carbon expect a 56% growth in global carbon market in 2008 to $92 billion from $59.Voluntary carbon markets have already been established and are expected to increase through 2050.

2) This assumes implementation will achieve 2,000 acres per year through 2030.

C. Afforestation/Reforestation of State Land Holdings:

1) State owned lands have a potential for reforestation/afforestation. This measure proposes planting about 4,500 acres annually for approximately twenty years. Each agency will need to seek the administrative and budgetary support necessary to fund achieving these outcomes.

2) CAL FIRE will work with other departments and agencies to identify suitable lands and opportunities for tree planting and will provide the technical assistance needed by those agencies to develop AR plans for the selected parcels.

3) Spring and summer of 2009 site preparation for AR will begin. This will continue in subsequent years until all selected parcels are prepared for reforestation.

4) Implementation will begin fall of 2009 .

D. USFS Reforestation:

1) Baseline USFS reforestation activity would result in 8,300 acres of reforestation in 2008 and 8,600 acres per year, starting in 2009. Based on the last 7 years of wildfire activity, the USFS has identified total reforestation needs of 21,000 ac per year starting 2009 and 24,000 per year from 2010 to 2050. That translates to 12,500 additional acres above baseline in 2009 and 15,400 additional acres per year after that.

2) Barriers to full implementation are fiscal (lack of funds), programmatic (existing sowing order) and technical (potential lack of seed and seedling stock). Full implementation will require budget augmentation, adequate forest seed production, and market expansion of nurseries and nursery stock. There may also be future carbon market opportunities for public lands that were not considered for this analysis.

E. Mitigation of conversion:

1) This assumes that 28,500 acres will be converted annually, based on projections by CAL FIRE's Fire and Resources Assessment Program (2003).

2) Implementation will be phased in, starting in 2009 with a goal for full implementation by 2014. Mitigation efforts by CAL FIRE and local entities could successively reforest on an annual basis 4,000, 10,000, 15,000, 20,000 25,000 and 30,500 acres. Mitigation will continue to 2050.

3) Barriers are largely political in nature: resistance to legislation, regulations or ordinances at state and local levels, particularly in the near term during housing start downturn.

7. Greenhouse Gas Emission Reductions

Greenhouse Gas Emission Impact

GHG emission impacts were quantified for the initiatives described above. Taken together, these four implementation approaches have the potential to result in annual emissions of -0.38 MMT in 2020, but as forest stands develop they will sequester an annual amount of approximately 5.95 MMT in 2030 and 21.72 MMT in 2050. The acres planted will have cumulatively sequestered 342 MMt CO_2 by 2050. The negative values in 2020 represent the removal of existing brush that is removed during reforestation. The model used to estimate GHG impacts does not consider reforestation projects that have already been implemented. As

a result reforestation projects that have taken place since 2005 and up to 2009 are likely to mitigate the actual emissions that are expected by 2020.

Methodology

The emission impact of A/R activities is driven by the acres of forest planted and the carbon stored per acre. Because these activities are executed on a project basis rather than on a per-year basis, carbon benefits and costs should ideally be calculated and considered for fixed project periods rather than on an annual basis. As summarized in the Winrock International carbon supply report (Brown et al. 2004a), the general steps needed for estimating the carbon supply and costs for a potential change in land use due to AR activities are:

a. Identify land use classes in which a change in land management could lead to a significant increase in carbon stocks
b. Estimate the area for each potential land use change
c. Estimate the quantities of carbon per unit area that could be sequestered as a result of the change in land use over a given time period, relative to a baseline carbon value
d. Estimate the total costs (opportunity costs associated with ranching cattle, site preparation and planting, maintenance, and measurement and monitoring)
e. Combine estimated quantities of carbon per unit area with the corresponding area and cost to produce estimates of the total quantity of carbon that can be sequestered for a given range of costs.

Assumptions

- The analysis assumes that mitigation from development may have to be implemented by local government agencies. There is some potential overlap between development on forest lands and development that is discussed in the Land Use sector.

- Projections of carbon and board feet were produced using the Landscape Management System (LMS ver. 2.0.46) software running the Forest Vegetation Simulator (1999). Carbon stocks on the site were assumed to be 10 tons of biomass, which was removed to allow for successful tree establishment. This created an initial emission. An “option C” baseline that mimicked the minimum stocking standards in the forest practice rules was modeled as a baseline, once thinning commenced, that simulated cutting all growth over time to keep a constant inventory level. Initially the baseline was the original carbon stocks assumed from shrubs. Projected management used the goal of harvesting either 75% or 50% of growth on 15-year cutting cycles. Additionality was the marginal increase in the difference between the projected management and the baseline. Simulations were performed for each of the five primary site classes and a weighted average based on the relative frequency of occurrence of each site class was calculated for prices and carbon yields. Site class V, the lowest site, was dropped as it was economically infeasible. A holdback of 20% of additionality for 20 years was simulated to mimic observed practice.

- The economic analysis used the outputs from the above simulations to calculate a price per metric ton of CO_2. A discount rate of 4% and cost of $30 an acre for inventory and carbon market participation was assumed. The establishment costs were assumed to be $1,100 an acre. Timber prices were taken from the latest Board of Equalization schedules ($235 per MBF for stumpage) and were kept constant. The price of carbon

was based on above and below ground carbon pools in the forest and long-term product storage. Yield Streams of carbon were based on the full life-cycle as estimated in LMS, which was based on the CORRIM project (2004).

1. CFIP Augmentation

Assumptions and carbon calculations:

a. This strategy is based on a funding level of $5 million per year of which $3.5 million will be directed to tree planting. At an average cost of $825 per acre to the State, $3.5 million will plant 4,242 acres annually.

2. Developing markets for GHG offsets at different price points:

Assumptions and carbon calculations:

a. The annual CO2 sequestered for each year is estimated by multiplying the number of cumulative acres planted by the annualized rate of sequestration.
b. The actual state market would not be implemented till after 2011, however it is assumed a private market will begin to operate before that time.
c. The average cost per ton of CO_2 was $18.68 with a range of $5 to $25 depending on site class and stocking. The lowest site class (V) was omitted as it was too expensive to be feasible.

3. Afforestation/Reforestation of State lands

Assumptions and carbon calculations:

4. USFS Reforestation:

Assumptions and carbon calculations:

a Full implementation will result in 15,400 additional acres planted annually at full implementation in 2010.

5. Mitigation of forest and woodland conversions.

a Reforestation will occur on 30,500 acres at full implementation in 2014.
b Annual sequestration rates, based on x yr project life, will be x per year.

<u>Uncertainty for All Approaches</u>

Uncertainty is undoubtedly large when scenarios include consideration of carbon markets that are as yet unformed and the impact of tax incentives that are not yet legislated. This uncertainty alone could be as high as 50 %. Previous studies (Brown et al. 2004b) illustrate the range of uncertainties in some of the input data used to calculate potential carbon benefits:

Identification of eligible areas:	
Federal and State Databases:	18%
Satellite Imagery:	10%
Carbon stocks:	18%
Linking carbon stocks to model:	16%
Harvest Assumptions:	8%

Using standard error propagation methods, the total uncertainty is estimated to be about 32% for all activities. When the uncertainty in area uptake is incorporated, it is likely that total

uncertainty will exceed 50%. Clearly this is an area in which more research could increase the certainty of the projected carbon sequestration.

8. Costs and Cost Savings

The cost of AR is driven by the acres planted and the cost per acre. Capital costs are classified as opportunity costs (profit foregone as a result of altered land use activities) and operating costs are calculated as the sum of conversion costs (one-time costs associated with site preparation and establishing tree plantings) and carbon measuring and monitoring costs. Because data on the contracting costs associated with carbon activities are scarce, it is assumed that these costs are zero. Since carbon markets calculate costs based on the life of a project, it would be most appropriate to analyze costs based on actual project life.

1. CFIP Augmentation:
    a. This strategy is based on a funding level of CFIP at $3.5 million per year for 10 years for a total of $35 million total.
    b. Recent CFIP expenditures indicate that total planting costs are about $1100per acre (site preparation, planting and maintenance). This analysis assumes that CFIP, which is a cost-share program, will be able to fund $825 per acre (approximately 75% project costs) and the project proponent will fund about $275 per acre. No capital costs are included in this analysis because most project areas are already being used for forestry purposes.
2. Developing markets for GHG offsets at different price points:

    To evaluate the range of potential project costs and revenues based on market behavior, two price points were considered: the price at a 4% real rate of return and at a 7% real rate of return. Given the resultant sensitivity to the discount rate, which was highly influenced by the high up-front costs, a relatively modest acreage of 2,000 acres a year was assumed.

3. A/R of State lands

Opportunity costs and implementation costs of afforesting suitable rangelands in California were calculated in Brown et al. (2004). Assuming no opportunity cost on state lands, the total cost (implementation costs only) of afforesting acres of state land would be million, or roughly $39 per ton of CO_2. Assuming an additional opportunity cost ($90/acre, as calculated for private land), afforesting the same area would increase the total cost to $274 million, or $46 per ton of CO_2. The inclusion of capital costs is not applicable for most state owned lands.

4. USFS reforestation.

The USFS estimates reforestation costs at $1,107 per acre. This consists of:

- $400 for site prep by hand felling
- $200 site prep for burning of felled (slashed) material
- $10 for cone collection
- $15 for seed
- $87 for seedlings
- $110 for planting
- $285 for hand release

5. Mitigation reforestation:

these costs would be assumed by the project proponent (landowner or developer) and would not require public funding appropriations. There are likely to be administrative costs associated with establishing a mitigation bank that have not been estimated.

Costs were assumed to include a one-time $30 per acre for inventory, preparation and verification cost to participate in the carbon market. This could be reduced based on specific circumstances such as having an existing inventory and management plan. Also, economies of scale will affect cost. Annual costs of forest management and carbon market participation were assumed at a constant price of $7.00 acre. All costs and revenues were discounted using a 4% real rate of return. The average cost per ton of CO2 was $18.68 with a range of $5 to $25 depending on site class and stocking. The lowest site class (V) was omitted as it was too expensive to be feasible.

Measure costs: Costs were quantified for the programs described above. If the proposed targets are achieved they would result in the following costs (units in millions of dollars):

PROGRAM	2020 Annual	2030 Annual
CFIP	4.7	4.7
MARKET	2.2	2.2
REFORESTATION OF STATE LAND	4.95	4.95
REFORESTATION OF USFS LAND	16.95	16.95
MITIGATION	33.6	33.6

9. Other Benefits

It is not anticipated that the afforestation/reforestation strategy will lead to reductions in emissions of pollutants such as VOCs, NOx, SOx and PM. However, the other benefits associated with the strategy are significant.

In addition to carbon sequestration, planting trees in areas suitable for afforestation provides other ecosystem benefits such improved water quality, wildlife habitat diversity, improved air quality, energy opportunities, and provision of jobs. Conversion of rangelands to forests in California also increases the aesthetic value of the landscape, and forest plantations could increase the timber value of the land if suitable species are chosen for planting.

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Climate Action Team
Forestry Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

The purpose of this document is to provide the public with information about options considered and analyzed by the Climate Action Team (CAT) Sector Sub Groups for Air Board's consideration and potential inclusion in the Scoping Plan. This information should be drawn from the Measure Analyses previously developed by each Sub Group.

Information should only be updated to reflect significant changes in technology, staff assignments, and understanding of the issues.

Outline

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Climate Action Team
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Scoping Plan Measure Development and Cost Analysis

The purpose of this document is to provide the public with information about options considered and analyzed by the Climate Action Team (CAT) Sector Sub Groups for Air Board's consideration and potential inclusion in the Scoping Plan. This information should be drawn from the Measure Analyses previously developed by each Sub Group.

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1. Measure: Urban Forestry

CALFIRE Urban Forestry, Voluntary Planting

2. Agency: Department of Forestry and Fire Protection

3. Measure Description

Urban Forestry is made up of several measures. A description of Urban Forestry is described followed by a brief description of the individual measures.

Overview

Measure 1: CALFIRE Urban Forestry

This measure has the goal of effectively offsetting and reducing emissions through expanding tree planting in urban areas. The annual emission reductions through tree planting (government and voluntary) are estimated at: 0.20 MMT CO2 in 2020, 0.81 MMT CO2 in 2030, and 2.28 MMT CO2 in 2050. The Department of Forestry and Fire Protection (Department) will work with private and public landowners, and local government in urban areas to encourage the planting of trees in strategic locations and of suitable species to provide maximum benefits of shade with minimal long-term care costs. These trees offset and reduce GHG emissions through three primary mechanisms:

- The trees store carbon as they grow (i.e., offset emissions).
- The trees provide shade that reduces energy use in buildings, provides for cooler temperatures in parked vehicles, and reduces the urban emissions from energy use.
- Urban wood waste can be used to produce electricity or alternative transportation fuels, thereby displacing the use of fossil fuels.

Trees will be planted in strategic locations around buildings, within parking lots and along streets to provide the benefit of reduced energy consumption. The strategic locations are those that allow a minimum number of mature trees to provide for the greatest amount of shade with the least amount of maintenance cost.

Measure 2: Voluntary Tree Planting

This measure recognizes the voluntary efforts that people take to plant trees on private property and through education and outreach will encourage the planting of residential trees to maximize shade and GHG benefits. As a voluntary action, homeowners commonly plant trees on their property for a variety of reasons. Collectively there is a likely carbon benefit from these actions

that is estimated under this measure. Voluntary planting provides an offset to GHG emissions and potential energy savings depending on the shade value of the trees planted. Retail sales from nurseries in California are substantial, estimated at over $10 billion annually, for lawn and garden sales. A proportion of the sales are associated with large stature trees, estimated at 2.4 million trees annually, and can provide significant carbon sequestration benefits. The Voluntary Program targets these 2.4 million trees that are going to be planted annually in California. Education and marketing can help achieve the strategic planting of these trees to maximize survival and benefits of half, and would result in an additional 1.2 million trees planted annually. Through city and community based organizations there are several major initiatives to increase voluntary tree planting in California. It has been estimated that there are over 240 million potential tree sites across the state can support additional urban forests (McPherson and Simpson, 2003).

Affected Entities

The affected entities for Urban Forestry include but are not limited to:

- Private Landowners: Residential and commercial landowners will be the primary entities planting trees under this strategy. Properly placed and maintained trees have been demonstrated to reduce cooling requirements.
- Public Landowners: Approximately 20% of urban areas are under public ownership including owners such as Cities, Counties, and CalTrans. Public owners can also reduce energy consumption in buildings by planting trees in strategic locations. They can also reduce energy consumption and off-gassing through shading parking lots and reducing cabin temperatures. Public owners have the additional contribution of being able to shade roadways and reducing the overall temperature of urban areas due to the Urban Heat Island Effect.
- Regulatory Agencies: Cities and Counties have regulatory authority through Tree Ordinances found in Municipal Codes or Zoning Ordinances. Many of these Tree Ordinances can be amended to reflect the multiple benefits urban trees provide. The Department Urban Forestry Program is working on developing a Best Management Practices guide that will allow communities to access the types of policies that encourage better urban forestry practices.
- Non-Profits: California has numerous non-profit organizations that are involved with management of urban forests. There are 75 member groups of California ReLeaf that are devoted to urban forestry issues in their communities. These groups reported over 350,000 volunteer hours in 2005 relating to urban forest activities. The California Urban Forest Council has 7 Regional Councils that bring together volunteers, City Foresters, Urban Planners, Utility Companies and the Tree Services Industry to work together towards improving Urban Forests. The Department Urban Forestry Program helps to coordinate these groups to leverage their individual skills and abilities on numerous projects across the State.
- Power Producers: Power producers will develop new generation capacity to use available urban wood waste, thereby displacing the use of fossil fuels in electricity production. A significant bio-power industry is envisioned to achieve the goals of the Interagency Bio-energy Working Group and California Biomass Collaborative.

Environmental Justice, Small Business, Public Health, Leakage and CEQA

Environmental Justice has been considered from the beginning of the public deliberations on Climate Change by both the California Climate Action Team and the Air Resources Board (ARB). Subsequent to the issuance of the 2006 Climate Action Team Report the State Legislature passed AB 32 (The Global Warming Solutions Act) and the Governor signed the bill. AB 32 became effective January 1, 2007. The bill carried Environmental Justice forward as an interest to be addressed in each of the major emission sectors. Forestry is one of those sectors. ARB established an Environmental Justice Advisory Committee (EJAC) as required by AB 32. This committee has had numerous meetings that have been advertised on the ARB website. Forestry Sector concerns were discussed in these meetings.

A set of public meetings addressing the Forest Sector were held in February 2008 for the AB 32 Scoping Plan. These meetings were also advertised on the Website to invite public participation. No Environmental Justice Issues were raised during those meeting.

EJAC raised one specific comment in recommendations on ARB Early Actions. Other possible concerns for the Forestry Sector are also listed below. Topics which need consideration for the Forest Sector are:

- The Committee has concern about the appropriate use of forest-based carbon sequestration and its potential as a long term solution for meeting California's GHG reduction targets.
- The use of chemicals in forest management activities.
- The use of offsets to permit continued pollution by regulated sectors.
- In Urban areas tree plantings should be appropriately distributed to all communities.
- Fire Suppression efforts should be equal amongst all communities threatened by large damaging wildfires.

There is some concern that tree planting under the California Department of Forestry and Fire Protections (Department) Urban Forestry program may not be evenly applied to all communities. This is addressed in guidelines used by the Department for Urban Forest grant application and awards.

Small Business
While additional tree planting in urban areas increases maintenance costs these activities may benefit small business involved in tree nurseries, landscaping and tree care.

Public Health
By filtering of air pollution urban trees have many positive health benefits. In addition, trees provide scenic benefits and are likely to attenuate noise.

Leakage
There are not likely to be any leakage effects associated with urban tree planting.

Related Objectives

The Strategy is Motivated by Multiple Benefits: Research in recent years has quantified the economic and environmental benefits of the urban forest. Trees reduce air conditioning costs, slow storm water runoff, help to reduce air pollution, provide wildlife habitat, increase property values, and extend the life of asphalt pavement. Trees also provide an important psychological link with nature for the urban dweller.

Strategy Metrics

The primary metric for each measure is the number of trees planted per year through 2020, 2030, and 2050. Other metrics include:

- The cumulative number of planted trees that survive over time.
- The portion of trees that are fast- and medium-growing hardwoods (as the mix of trees planted affects the overall growth rate).
- The portion of trees planted on private land (which will primarily affect who bears the maintenance costs).

In addition to these metrics, costs and benefits will be tracked, including CO2 sequestration verification with periodic monitoring.

As a significant portion of the strategy involves using urban green waste to produce energy, that aspect of the strategy will be measured in terms of production capacity and GWh produced.

Measure Goals and Potential Implementation Approaches

CALFIRE Urban Forestry

The strategy has the goal of obtaining sequestration of 4.0 million metric tons of CO2 in new tree plantings by the year 2030 and 15.2 million metric tons by 2050. To meet this objective approximately 5 million urban trees would have to be strategically planted by 2010. There is no single approach to accomplishing this level of planting in the urban environment. Rather, a combination of related activities, with Department leadership and technical assistance, is needed to realize this goal. In addition, this strategy calls for an increase in education and outreach programs to target voluntary planting of residential trees that will maximize the GHG benefits. The contribution from voluntary planting will add additional carbon sequestration well beyond government funded initiatives. Collectively, the measures that implement the strategy will result both in additional carbon sequestration and substantial energy savings. The GHG benefits increase dramatically over time as trees mature with age.

Funded Activities: Several activities require funding to be executed, including the following:

1. Urban Forestry Program. The Department administers the Urban Forestry Program, which has had intermittent funding since its commencement in 1978. Since 1998 over 135,000 trees have been planted through direct grants from the program. Grant funds have come through proposition-based funding and annual grants from the USDA-Forest. The Urban Forestry Program has a network of 75 non-profit groups, 7 Regional Urban Forest Councils that bring together City Foresters, Planners, Developers, Engineers, and Research Scientists with these non-profit groups. Recent enhancements of General Fund resources and bond fund resources for the Urban Forestry Program have enhanced the program's capacity to provide education, technical assistance, and grant funds, as well as to conduct special projects.
2. Proposition 12 Grants: The Department Urban Forestry will continue to implement Proposition 12 Grants that are solely for tree planting and 3 years of maintenance for those trees planted. Grant funds will be completely exhausted in FY 2007/2008 and will result in the planting of 15,000 – 25,000 trees in strategic locations.
3. Proposition 40 Funds: The Department Urban Forestry will implement Proposition 40 funds of $10 million dollars as the funds are released. To date $3 million dollars have been released for urban forestry grants pursuant to the California Urban Forestry Act. Grants for

FY 2007/2008 are being accepted at this time and will be for various urban forestry programs such as tree inventories, urban forest management plans, educational programs and a host of other topics. Available grant funding for the year is $2.6 million. These grants will directly support urban forestry within urban communities and indirectly support increased tree planting. It is expected that many of the projects will lead to an increased awareness of how, where and why to plant and care for urban trees to maximize the benefits they provide while lowering the per tree maintenance cost.

4. Proposition 84 Funds: Proposition 84 was approved by the voters in November 2006. Under Section 75065(a), the 2007/08 Budget approved Department implementation of 10-year Urban Greening Program. It approved ongoing program operation funding for the 10-year program and the first year's grant funds of $2.8 million. Grants applications are currently being accepted in areas including education, innovative projects, tree planting, and biomass utilization.

The combined resources available from these sources are inadequate to fund the planting of 5 million trees in urban environments. Additional resources are required to achieve the full objectives of the strategy. Cooperation with, and assistance to other organizations will help expand the program and leverage staff resources and expertise.

Cooperative Activities: The following cooperative activities will promote the program goals.

1. LA Moran Nursery in Davis: The Department will work to improve the type and sizes of trees produced to better match the needs of the urban forestry program.

2. State Land: The State of California has significant landholdings in urban areas including public buildings and road right of ways. The Department Urban Forestry will work with other state agencies to encourage increased strategic planting of trees to reduce energy consumption around buildings and parking lots and reduce the Heat Island Effect by shading roadways.

3. City of Los Angeles: The City of Los Angeles has begun a Million Trees campaign which will plant one million trees within the City of Los Angeles. The Department Urban Forestry will continue to provide technical support to the City and the non-profit groups working on this project. The Department Urban Forestry has helped facilitate this event by working with our existing partners. CAL FIRE-Urban Forestry has awarded $1,133,425 in grants to organizations supporting the Million Trees Los Angeles effort. Of this amount, $233,425 is directly supporting MTLA activities through 4 nonprofit groups. An additional $900,000 is supporting organizations that are in turn providing significant resources towards the MTLA effort and will be planting over 1/3rd of the trees.

4. Non-Profit Groups: The Department will continue to work cooperatively with non-profit groups to promote urban forestry. Examples include the United Voices for Healthy Communities and the Sacramento Tree Foundation.

5. Best Management Practices (BMPs): The development of BMPs provide decision makers, city planners, landowners, developers, and citizens with land-use approaches to conserve, enhance, and manage the multiple benefits provided by urban forests. Fundamental to improved management practices is the need to inventory and monitor the condition of urban forests within communities.

6. Sacramento Tree Foundation: The Sacramento Tree Foundation developed a Greenprint Initiative that establishes a goal of planting 5 million new trees in the Sacramento region.

7. Tree Ordinances: There are hundreds of city and community tree ordinances throughout California that are designed to govern the placement or removal or trees in public areas. Other ordinances are designed to protect native trees and trees of historical significance. Through education public awareness and the effectiveness of tree ordinances can be improved and are an important component to managing urban forests.

Voluntary Tree Planting

The goal of this measure is to account for the voluntary tree planting that takes place across the state. Since homeowners regularly plant trees on a voluntary basis there are no needed implementation approaches. The use of education and outreach programs would enhance the type of trees, the location that trees are planted, and the derived shade benefit. There is also a need to improve the tracking and accounting of voluntary tree planting.

Other Activities: Additional activities will be undertaken to support the program goals. Of particular import is to support progress in the deployment of technologies that can convert urban green waste into fuels or energy. As urban green waste is a relatively consistent supply of materials, and there is virtually no opposition to the "harvest" of such materials, the Department Urban Forestry Program will continue to look for economically viable solutions that can keep useful fiber materials from being disposed of in a landfill. Under this implementation approach, it is assumed that a portion of available urban wood waste from Urban Forestry (ongoing thinning and pruning) will be used for new bio-power generation, rather than being landfilled, to help the state meet its waste management and bio-power goals in the Bio-energy Action Plan (CEC 2006b,c).

The state could also work with the California Climate Action Registry to develop and adopt a protocol for the certification of GHG emission reductions from urban forestry programs. This protocol would help attract needed additional investments in urban forestry projects.

Non-Quantified Stakeholder Suggested Measures – Two Stakeholders meetings were held in February to request submission of recommended measures to meet the AB 32 GHG emission reduction targets for 2020. Additional measures were suggested that could assist in enhancing GHG benefits, however the Department of Forestry and Fire Protection cannot analyze or recommend these at this time.

- Tree planting by utilities
- Mitigation of conversion (e.g. offsets and banking)
- Public Goods Charge to fund multiple measures
- Research and pilot projects
- Third party review of projects
- Tracking and documentation.

4. Technology

The basic technologies for seedling establishment, tree planting, and maintenance are widely available throughout the state, and already utilized by federal, state, and local programs. The benefits obtained by tree planting vary depending on species selection and location. Fast growing species accumulate carbon and provide shade at a more rapid rate than slow growing species, though slow growing species may be favored for aesthetic, wildlife habitat, or other reasons. In general, energy savings are maximized when trees are planted on the west side of homes, which provides the greatest amount of shading during the hottest hours of summer days.

The tree mortality loss is estimated at 6% in the first year following planting. Subsequently, a 1% mortality loss is estimated for each year. These values are conservative relative to Forest Service experience, which finds mortality in the first 5 years after planting to average 1% (equivalent to roughly 5% first-year mortality), and then drop to 0.5% per year. Plantings of well selected and maintained fast-growing tree species, accompanied by favorable environmental conditions, public outreach, and community participation may reduce first-year mortality to as low as 3%. Alternatively, if tree species are not well selected or maintained, planting is done by untrained volunteers, and environmental conditions are unfavorable, first-year mortality can be as high as 9%, with subsequent annual mortality of 2%.

The technologies required to produce electricity from green waste are also well developed but not yet widely available. However, additional electric power generating capacity capable of using green waste will be required in order to achieve the goals of this strategy.

5. Statutory Status

The following areas will or may need legislative action:

a. The California Urban Forestry Act of 1978 (Public Resources Code Section 4799.06-4799.12) gives broad authority to the Department to implement an Urban Forestry Program. The specific purpose to "Maximize the potential of tree and vegetative cover in reducing energy consumption and producing fuel and other products" is provided.

b. New tax credits or other incentive for those investing in urban forestry projects would help advance the program goals.

c. Reliable funding for an ongoing Urban Forestry Program that allows for greater distribution of cost share assistance would also help advance the program goals.

6. Implementation Steps and Timeline

Each of the implementation efforts above are addressed individually below –

1) Department-Urban Forestry Program Augmentation:

   a) Work to augment the level of funding for the Urban Forestry Program through grants, bond funds, and other funding opportunities. Increase the proportion of the USDA-Forest Service Grants put directly into projects.

   b) January 1, 2009 provide the legislature a monitoring report summarizing the number of strategically planted urban trees with a projection of carbon sequestration and energy reduction.

2) Proposition 12 tree planting grants:

   a) Applications are currently being accepted for FY 2007/2008 grants totaling $1.7 million These grants have a project deadline of March 2010.

3) Proposition 40 urban forestry grants:

   a) Total Proposition 40 urban forestry funding to the Department is $10 million and will be released as grants over three fiscal years through 2008/09.

   b) The Department is currently accepting applications for FY 2007/2008 urban forestry grants and will be funding $2.5 million of urban forestry projects. Projects will have a deadline of March 2009.

   c) Projects funded under Proposition 40 can be given priority to those projects that aim to promote reduced energy consumption and increased carbon sequestration.

4) Proposition 84 urban forestry grants:

   a) Starting in the 2007/08 fiscal year, The Department began implementation of a 10-year Urban Greening Program that will include grants, education, and technical assistance, as well as Department implemented projects.

5) Department Nurseries to provide urban tree:

   a) Beginning in 2007 the Department-Urban Forestry Program started work with the Department Nursery Program to develop a species list and propagation sources for trees suitable for growing in urban environments.

   b) Using the existing Standards for Nursery Trees developed by the Department, trees will begin being grown for application in urban forestry plantings throughout the state.

6) The Department Urban Forestry will work with other state agencies to encourage increased strategic planting of trees to reduce energy consumption around buildings and parking lots and reduce the Heat Island Effect by shading roadways.

7) The Department will continue to work with the City of Los Angeles and the partnership that has been formed to plant 1 million trees within the City.

8) The Department will continue to work with United Voices for Healthy Communities, the Sacramento Tree Foundation and others.

9) Portable sawmill and wood utilization:

   a) The portable sawmill program will continue and sawmills will be placed in areas where large amounts of wood can be converted to useful products.

   b) The program at Palomar College that has had a portable sawmill will be requested to create high quality crafts that can be given as awards to people and organizations that promote large-scale tree planting projects.

10) The Department will work with the Interagency Bio-energy Working Group and California Biomass Collaborative to promote investment in new bio-power facilities using urban wood waste. This will address waste management goals (divert some urban wood waste from landfills) and Bio-energy Action Plan goals (total 1,450 MW of new bio-power capacity by 2020 to meet Renewable Portfolio Standard and Executive Order S-06-06 targets (CEC 2006b)). It is expected that bio-power from urban wood waste may be able to contribute around 250 MW toward this goal. New investments are expected to begin in 2012 and continue through 2020.

7. Greenhouse Gas Emission Reductions

The expected GHG emissions reductions account for CO_2 sequestration in woody biomass from tree growth alone, minus CO_2 emissions from maintenance activities and the decomposition of trimmings and dead trees. By 2010, over 6.2 million trees will be planted, sequestering a relatively modest 0.03 MMT CO_2 per year. By 2020, over 5.5 million of these initial trees will still be alive, with a higher annual sequestration rate of 0.14 MMT CO_2 due to 10 years of growth for the surviving trees, and by 2030 this will increase to 5 million trees sequestering 0.25 MMT CO_2 per year. GHG emissions reductions from CO_2 sequestration will continue well beyond 2030, but will eventually level off, as growth slows and is offset by senescence and mortality.

The carbon sequestration rate of the growing trees is computed using estimated growth rates for the trees. Urban trees typically sequester 20% less CO_2 per year than forest trees, due to thinning and leaf removal, which reduces living biomass and decreases carbon accumulation in the soil. This strategy uses a model created by Winrock International, in which CO_2 accumulation is based on tables published in *Method for Calculating Carbon Sequestration by Trees in Urban and Suburban Settings* by the Energy Information Agency (USDOE EIA 1998). These tables provide annual CO_2 sequestration for hardwoods and conifers with slow, medium, and fast growth rates. The model assumes a planting mix of 80% hardwoods (10% slow-growing, 30% medium-growing, and 40% fast growing) and 20% conifers (10% medium-growing, 10% fast-growing). This planting mix is similar to that found in many urban settings, and favoring faster growing hardwoods, which will provide the most rapid CO_2 sequestration and energy savings in most California urban settings.

Additional GHG reductions are also expected to come from reduced electricity consumption. Energy savings are linked to tree growth since taller trees with larger canopies provide more shade and more effective wind breaks. The Winrock model predicts that the full implementation of this urban forest strategy will result in annual electricity savings of 27 GWh in 2010, 163 GWh in 2020, and 180 GWh in 2030.

Finally, urban wood waste can be used to produce electricity. According to the California Biomass Collaborative 2005 biomass resource assessment (CEC 2005), the total technical potential availability of municipal biomass is 9.7 million dry tons per year (MDT/y), of which 9.2 MDT/y is municipal solid waste (MSW) potentially diverted from landfills. This corresponds to 1,071 MWe technical potential, or 8,590 dry tons per MW. Not all MSW is urban wood waste. A 1995 California Integrated Waste Management Board report notes that approximately 3.3 million tons per year of waste wood are disposed in landfills statewide (CIWMB 1995), some of which would be tree thinnings and prunings but also construction wood (D. Wickizer, Department of Forestry and Fire Protection, personal communication. 12/11/06). If 2 MDT/y of the total represents urban wood waste that could potentially be diverted for bio-power, at 8,590 dry tons per MW it would be feasible to produce 237 MW.

The proportion of available urban wood waste that will be used for new bio-power capacity will depend on investment in new facilities sited in/near major urban centers, and gradually increasing over time. The economics of such plants would potentially be attractive: a geographically concentrated fuel supply would reduce transport costs and thus the contribution of fuel cost to overall cost of electricity ($/kWh), and diverting this biomass from landfills would avoid tipping fees (a negative cost, also reducing price paid for fuel). On the other hand, new investments require time and coordinated state support, including siting and permitting.

For the present analysis, assuming coordinated interagency support from the members of the Climate Action Team and Interagency Bio-energy Working Group, we assume it might be possible to divert two-thirds of the potential urban wood waste by 2020, or 2 MDT/y.[1] This amount of wood waste would result in 237 MW new bio-power by 2020. This assumption is ambitious in relation to current levels, but small (16%) in relation to new bio-power capacity needed to meet state targets for 2020.

These investments would begin in 2012 and continue incrementally to reach 237 MW by 2020, with about 26 MW added per year. Assuming 85% capacity factor, 237 MW in new bio-power capacity would produce 1,764 GWh/y by 2020

[1] This rate is computed as: 9.2 MDT/y total MSW diversion potential * 33% urban wood waste within MSW * 67% developed for bio-power = 2 MDT/y.

Voluntary Tree Planting

The contribution of voluntary tree planting was estimated as a portion of the $10.8 billion in retail sales from lawn and garden sales. An estimated 40% of the $10.8 billion is spent on green goods. Assuming that sales parallel production rates it was estimated that 29.7% of the sales of all green goods would therefore be of woody, deciduous and evergreen ornamentals. This assumption yields sales of $1.284 billion of woody, deciduous and evergreen materials in California per year. At a cost of $100 per tree, this would equal 12.8 million Woody, Deciduous and Evergreen Ornamentals per year. If we further assume 20% of these units are large stature trees, we can conservatively assume 2.56 million trees are planted for purchase in California annually. With 94% of the households in California being located in Urban Areas, the 2.56 million trees can be reduced to 2.4 million trees planted in Urban Areas of California per year. The Voluntary Program targets these 2.4 million trees that are going to be planted annually in California. Through education and marketing, the strategic planting of these trees to maximize survival and benefits of half, would result in an additional 1.2 million trees planted annually.

The GHG benefits were estimated using the methods described above. The analysis assumed a 2009 starting date and assumes that trees are planted only through 2030. Planting 1.2 million trees per year for 20 years results in 13 million trees planted in 2020 and 22.6 million trees (adjusted for mortality) in 2030. The CO2 benefits through additional carbon sequestration are estimated at: 0.17 MMT per year CO2 in 2020 and 0.55 MMT per year CO_2 in 2030.The cumulative CO_2 reductions are estimated at 1.10 MMT CO_2 in 2020 and 6.19 MMT CO_2 by 2030. These GHG emissions reductions account for CO_2 sequestration in woody biomass from tree growth alone, minus CO_2 emissions from maintenance activities and the decomposition of trimmings and dead trees. As existing trees continue to grow and new trees are planted GHG emissions reductions from CO_2 sequestration associated with voluntary planting will continue well beyond 2030.

8. Costs and Cost Savings

The initial capital cost associated with this urban forestry strategy is the cost of tree planting, including acquisition of appropriately sized trees, site preparation, planting and staking. Total planting cost in California can vary between $45 and $160 per tree. The Winrock model assumes a planting cost of $100 per tree, which is similar to the $96 per tree average achieved by the Department for urban forestry projects in 2005 and 2006.

Once trees are established, maintenance costs are initially minimal, but begin to accrue after roughly 10 years, as trees need to be pruned and hardscape needs to be repaired from root damage. Additional maintenance costs include inspection, administration, legal claims, disease control, removals, and storm litter clean-up. Maintenance costs are typically higher for trees planted in public spaces, since they require more frequent pruning to avoid interference with power and telecommunications lines, and are also generally adjacent to streets and sidewalks. From the findings of the Forest Service's Center for Urban Forest Research, annual maintenance costs in CA averaged $19 per tree for public land, and $14 per tree for private landowners. The Winrock model uses these values and assumes that 50% of program tree plantings will take place on public lands, with the remainder sponsored by private landowners.

The final cost associated with the program is measuring and monitoring to measure GHG impacts and obtain real-world verification of cost and benefit estimations. Measuring and monitoring will be minimal relative to planting and maintenance, since only a small portion of the total population will need to be evaluated to statistically verify carbon, costs, and benefits. The

Winrock model assumes that 5% of the surviving tree population is sampled every 5 years, with a cost of $2.19 per tree, comparable to current per tree inspection costs for urban tree plantings in California.

Urban tree plantings also yield significant cost savings, particularly when trees are planted to maximize reductions in energy use. As already mentioned, the model predicts an annual electricity savings of 27 GWh in 2010, 163 GWh in 2020, and 180 GWh in 2030. Standardized electricity prices are used to value these energy savings, and are reported separately.

Less apparent, but often even more significant, is the ability of trees to remove pollutants from the atmosphere as it is absorbed through leaves or adheres to trunk, leaf, and limb surfaces. Pollution removal rates are proportional to size and surface area, and are therefore also linked to growth and carbon accumulation. Pollutants removed include ozone (O_3), nitrogen dioxide (NO_2), small particulates (PM10), and volatile organic compounds (VOC's). Actual pollution removal will depend on local pollution concentrations as well as growth and surface area, and the value for the removal of each individual pollutant will vary based on market prices and the need for pollution abatement. The Winrock model assumes a flat rate of pollution removal linked to carbon uptake, 0.03 tons of pollution for each ton of CO_2. These values are based on research conducted and published by the Forest Service on urban tree pollution removal in Berkeley, Claremont, Modesto, and Santa Monica CA.

Another cost savings associated with urban trees is attributable to interception of rainfall on tree surfaces, which reduces stormwater runoff and flood potential during rain events. Like pollution removal, rainfall interception is also linked to tree size and surface area. The Forest Service has calculated rainfall interception quantities and dollar values for the San Joaquin Valley, the Inland Empire, and Coastal California, based on meteorological data and modeling. The Winrock model uses conservative averages from these values linked to CO_2 sequestration, 4.73 gallons of rainfall per year for every pound of CO_2, at $0.0002 value per gallon of rainwater interception. While rainfall interception values are typically small relative to energy and pollution removal savings, they may be significant in Coast Range communities subject to frequent winter flooding.

Finally, there are other benefits from urban trees that can be quantified as cost savings in a less direct fashion. One is increased property value, measured as the increase in sale price of analogous properties with and without established trees. Trees also provide wildlife habitat, offer recreation opportunities, provide scenic beauty, and generally enhance human health and well-being, which can help explain property value increases when combined with the cost savings already mentioned above. The Forest Service's Center for Urban Forestry has attempted to account for all these values in several regions of California, which range from $132 to nearly $4,000 per metric ton CO_2. The Winrock model used in this strategy takes a conservative average of $199 per metric ton CO_2 from Forest Service research to estimate annual cost savings from other benefits, with these benefits again linked to tree growth through carbon accumulation.

Work by the Forest Service, the Department, and other institutions have consistently demonstrated that the cost savings associated with urban forestry will exceed program costs once trees are given time to mature and accumulate benefits. The results of the Winrock model support this conclusion. After the initial capital cost of planting is fully invested by 2010, cost savings will be consistently higher than operating costs. The Winrock model predicts that irrespective of energy and CO_2 reductions, that cumulative project costs (Capital Costs + Operating Costs) will have a payback period of 19 years (from 2005), with the strategy becoming net economically positive in 2023. When energy savings and CO_2 reductions are

factored in, this investment and operating payback period reduces to 16 years, with 2020 posting a net economic return of $25 million and greater returns for all years thereafter.

As mentioned, all costs and benefits are linked to the timing and quantities of tree planting, highlighting the importance of the primary metric, number of trees planted, and the second metric, cumulative number of trees (plantings – deaths). All benefits are linked to CO_2 sequestration as a proxy for growth, which in turn depends on when trees were first put in the ground. Growth will also be affected by species composition, which is tracked by the third metric, the percentage of fast- and medium-growing hardwoods planted relative to total plantings. Maintenance costs are also linked to the timing of planting, since they also are not assumed to be significant until 10 years after planting, and are additionally linked to the fourth metric, the percentage of trees planted on private lands.

There are many sources of uncertainty in the model approach, which will only be fully eliminated through implementation and monitoring. Initial planting costs should not deviate by more than ±20% from the model's $100 per tree assumption, although a wider range has been reported. The variation in maintenance cost should not exceed ±15%, linked primarily to the percentage of trees planted on private land (Metric 4), but wider variation has also been reported.

There is much higher potential for variation in cost savings in the model, due to dependence on many more factors. As with carbon, value of cost savings will be highly dependent on growth, which will vary depending on location, species composition, survivorship, etc. Location will also dictate real savings from flood avoidance, summer shadings, and pollution removal, due to both variations in environmental conditions and market prices. When all factors are adjusted according to reported optimistic and pessimistic scenarios, total variation in cost savings averages between +105% and -50% annually.

Capital costs for new biopower range from $1,500 to $3,000 per kWe, and levelized operating costs range from $0.06-0.08 per kWh (CEC 2005). This estimate includes an optimistic base fuel cost of $20/BDT; each additional $1/BDT fuel cost results in approximately $0.001/kWh increase in levelized cost. These figures also assume 20% net efficiency and 85% capacity factor. Federal and state tax credits and incentive payments are available for biomass, but have been inconsistently funded and tended to discriminate against biomass relative to other renewables despite greater economic and environmental co-benefits from biomass (CEC 2005, 2006b, c).

For bio-power plants using urban wood waste, fuel costs could be relatively low compared to other bio-power facilities, due to reduced transport costs (a geographically concentrated and relatively constant or growing supply) and avoided landfill tipping fees (a negative cost). We therefore assume the $0.08/kWh levelized cost based on $20/BDT fuel cost to be appropriate if not conservative.

Voluntary Tree Planting

There are no direct costs associated with voluntary tree planting beyond increasing the capacity of state and local government to conduct education and outreach for Urban Forestry. It is estimated that the cost of increasing education and outreach at state and local levels would be $5 million dollars annually. The costs would allow state, local government, and non-profit groups to develop and implement outreach programs to landowners.

9. Other Benefits

The Winrock model has attempted to monetize all costs and benefits directly associated with this urban forestry strategy, based on the best available research. Related benefits from reductions in pollution emissions from reduced energy use, including NOx, VOCs, and particulate matter are computed using standardized emissions factors across all the strategies and are reported separately. There is also evidence that urban trees decrease cement deterioration through shading, which may partially help to offset hardscape resurfacing costs, but this is not modeled. When vehicles are parked in the shade vehicle temperature is lowered, decreasing fuel and chemical off-gassing emissions, though a valuation of reduced off-gassing is also not included in the Winrock model.

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